CORPORATE MANAGEMENT PROCESSES IN THE ADOPTION OF POLLUTION CONTROL EQUIPMENT

A Thesis Submitted
In Partial Fulfilment of the Requirements
for the Degree of

MASTER OF TECHNOLOGY

by

CHANDRANATH BANERJEE

to the

INDUSTRIAL AND MANAGEMENT ENGINEERING PROGRAMME

INDIAN INSTITUTE OF TECHNOLOGY, KANPUR

APRIL, 1988

CERTIFICATE

This is to certify that the present work on " Corporate Management Processes in the Adoption of Pollution Control Equipment" by Mr. Chandranath Banerjee has been carried out under my supervision and has not been submitted elsewhere for the award of a degree.

(Arun P. Sinha)
Assistant Professor
Industrial & Management Engg.
Indian Institute of Technology,
Kanpur 208 016

April, 1988

ACKNOWLEDGEMENTS

The author wishes to express with all earnestness his appreciation and sincere gratitude to Dr. A.P. Sinha for his continu interest, encouragement and valuable guidance throughout the progress the project.

Every student's insight and judgment are formed by interacti with a multitude of people, most of whom are anonymous even to him. have had the good fortune to participate in many interviews informal conversations with many managers and engineers. Inevitably, virtue of propinquity, temperament and capability, some stand out. the many names that come to mind, Mr. K. Venkatraman, Mr. Mayoornadhan, Mr. S.A. Khan, Mr. T.N. Enti and Mr. K.S. Shetty warr special attention.

I am also grateful to the Institute administration which at times rendered the facilities needed for carrying out the project work

I am thankful to Prof V.P.Sinha for his timely help in printing this thesis. Mr. P.K. Khan took exceptional pains both in drawing figures and calligraphy, for which I am most appreciative.

I thank Swami Anand Chaitanya for deciphering my hieroglyphics formatting the text of the thesis.

The author owes an even deeper debt of gratitude to innumerab comrades and colleagues for their valuable suggestions, direct indirect, during the course of this project.

April, 1988

Chandranath Banerjee
Roll No. 8611403

CONTENTS

ABSTRACT

This study is about how organizations go about making the strategic decision of pollution control equipment adoption. For this purpose data was collected from 13 firms - 3 from Pulp and Paper Industry, 5 Cement Industry and 5 Fertilizer Industry - partly through field study (personal interviewing) and also through mailed questionnaire.

The cases were analyzed with a focus on the differences in strategic response of the firms. Insights gained about the organizational decision making process has been delineated. The impact of various factors like techno-economic factors, equipment attributes, etc. on the adoption of pollution control equipment has been studied.

Conclusions are sought regarding the importance of various factors, management and organizational design implication of the findings and some implications at the Government policy level. Besides a broader analytical framework of decision making process has been discussed.

CHAPTER I

INTRODUCTION

This study is about the decision making process in the adoption pollution control equipment. Any process exists within a giv environment. The analysis of the environment and the recognition of peculiarities are an important and inescapable preliminary to understanding of the process itself [34]. One of our main objective therefore, is to assess the influence of the environment on adoption, studying the part played by various factors in channelling decision making process.

Social and economic policy makers tend to expect research adoption decision to provide guidance in two directions. First, should indicate how new equipments (pollution control) are likely to adopted and what their foreseeable economic and other impacts industry and society are. Secondly, it should analyze and assess thos policy measures which might promote the adoption decision [44].

Literature on adoption decision making process cannot yet fulfil these expectations. In actual fact there exists as yet no comprehensiv theory to describe and explain all the ways in which adoption decisio (of pollution control equipment) can occur in real life. We may have accept that several theoretical approaches are required to explain various ways in which adoption decisions of pollution control equipmen occur.

Actual adoption decision making cases lack similarities,

analysis of a few cases by means of a uniform methodology may help identifying the regularities in the process which is a necess. condition for tentative general statement. Our analysis consists investigating the connection between numerous features in the adopt: decision of thirteen cases which are drawn from three industries -Pı and Paper, Cement and Fertilizer.

The area of pollution control was selected for this inquiry becaı industrial pollution of the environment has long been a world wi problem. Little about adoption can be learned through natural occurring events. Because all naturally occurring events are compos of routine and programmatic reactions. New insights about adapti mechanisms come primarily from observing events which disru organizations' usual reaction patterns as is in the case of control environmental pollution [31]. Moreover, it was felt that concentrati on adoption decision of pollution control equipment would not only le to a clearer conceptualization of what constitutes a decision, how may be functionally classified, and the conditions and process involved in making it but would also manifest how such decisio radically differ from other product/process equipment adoption.

1.1 Rationale of Study

One of the most important stages of the process of industri pollution control of the environment is adoption of pollution contr equipments/processes. Since the rate of adoption is the rate at whi a new technique (equipment or process) is actually put into use, it is critical determinant of the rate of growth of concern for protecting environmental quality. If certain types of firms and industries quicker to adopt a new, more efficient equipment/process they

quicker to attain the resulting standards of pollution control as set Pollution Control Board. It would certainly seem useful, particula from the point of view of public policy, to develop convincing empiri evidence concerning the characteristics of such adoption decision mak process.

1.1.1 Previous Research Studies

Adoption studies in the past have been represented by two m tradition of research - studies of "technology transfer" and studies the "diffusion of innovation". The essential difference between the traditions of research - technology transfer and the diffusion innovations - is that technology transfer studies have tended emphasize the point to point transfer mechanism whereas the diffus literature has dealt with the pattern of spreading an item over ti Spencer and Woroniak [41] brought out the distinction between the te "diffusion of innovations" and "technology transfer" by attributing element of planning and purposiveness in the latter. According to th this purposiveness manifests itself by conscious, predetermined eff and commitment of resources to transfer technology to others, where the diffusion process denotes an element of naturalness. Based on analysis of the literature, it can be noted here that the two process are not mutually exclusive; a researcher working in one tradition m draw on the knowledge available in the other. This study is primar an analysis of the equipment adoption process viewed as point to phenomenon; however, we have drawn from the diffusion literature definition and measurement of our variables.

As mentioned by Tornatzky and Klein [43], in most of the studi poor measures were used to study too few of the characteristics of

few innovations. The majority of the studies examined one or only characteristics in a given setting. Very few studies concentrat organizational adoption process.

Our study makes a modest attempt to overcome some of shortcomings by studying the influence of other independent vari (techno-economic and organizational) in addition to innovation/equi characteristics. The other purpose is to analyze the cases of ado using a standard frame work and to develop a tentative process mode possible.

1.1.2 Industrial New-Equipment Adoption Decisions

Recent progress in developing a body of knowledge about "b behavior" has been heavily weighted in favor of "consumer" (individual and household) behavior. Very few studies of indust buyer behavior have been reported, the total available theory empirical knowledge is meager and disjointed. But the need is gr Whether one's motivation is that of the practitioner or the researc each new venture into industrial markets seems to pose the same dan and to be hindered by the same blind spots. Nowhere can the need fo more complete understanding of industrial buying be better seen than the decision to introduce a new equipment or service [46].

The body of theory and empirical knowledge applicable to industr buyer behavior is not as meager, however, as review of the market literature would indicate. The economist and the sociologist particular have an important contribution to make [47]. One object of this study is concerned with drawing together several resea findings from economics, sociology, and marketing in a way that perm a useful analysis of new equipment adoption decisions.

1.1.3 On the Decision-Making Context of Adoption

Adoption of pollution control equipment is a strategic decisi Such decisions would be based on estimated effects on the performance the firm over an extended period of adopting verses not adopting using other means of dealing with its problems and opportunities [1' Understanding such decisions accordingly requires some grasp of larger strategy formation process.

In addition to this, the study is intended to explain interf: differences in the adoption decisions arrived at - thereby allow: consideration of the 'firm specific' factors, including its distinct: pressure and managerial objectives, which may overshadow the firn general economic characteristics in influencing the direction and tim: of adoption decisions.

Diffusion studies tend to overlook the frequently dominant, always important role of the environment. Major elements of environment would include: nature and urgency of the firms need, availability and relative advantages of non-technological as well technological means of meeting such needs, and the extent of technica managerial and financial resources available for allocation to su efforts [16]. In view of such a broad range of potential differences managerial concerns, there is obviously little basis for assuming all firms in the seemingly relevant industrial grouping are even serious consideration to the same equipment within any given year.

The study is also expected to focus on evaluation processes. involve analyzing benefits and burdens vis-a-vis delaying the action consideration of the availability of financial and technical resource:

CHAPTER II

ENVIRONMENTAL PROTECTION - POLLUTION CONTROL

Environment is a limited resource, with conservation as the influence restraining consumption. Some go further, foretelling large-scale starvation and pollution unless we turn back the clock and adopt a simpler way of life [24].

In this chapter, an effort is made to present a brief account of the interaction between industry, man and his environment.

2.1 Why Pollution Control?

On an increasingly crowded planet the argument applicable to energy is beginning to apply to those resources such as air, water and space, which we have traditionally been able to regard as abundant free gifts of nature. For they, like energy, have quality - the cleanliness and freshness of air, purity of water, greenness of landscape - which we value and which in the more densely occupied parts of the world is becoming scarce.

Pollution is usually regarded as the release, into a shared environment and against the common interest, of an offensive by-product or waste. From the economic standpoint, pollution is the consumption of environmental quality. For example, a smoky fire consumes clean air and replaces it with soot-laden air. Thus, environmental quality can be considered as an input, to any economic activity, such as labor, capital and raw materials. In words of W. Beckerman [3] 'pollution is

objectionable because it constitutes the "using up" of a resource to which we attach value, such as clean air, or water, or peace and quiet... . If we could always provide ourselves with unlimited amounts of clean air or water we would not mind how much of it was "used up" by the polluter ....' The key point is that the environment is a scare resource and pollution is, in effect, a use of this resource.

2.2 Environmental Pollution - Whose Problem?

Pollution has traditionally been an urban problem. Now, pollution has also become a rural problem, through the discharge on to the land, water and air, of water pesticides, fertilizers, animal effluent, and mining and industrial debris. It could even become a global problem, due to the emission of carbon dioxide, nitrous oxides, smoke, waste heat, nuclear materials, DDT and aerosol chemicals into the atmosphere. That the global environment has only a limited ability to absorb the effects of a major assault upon it was shown by the Krakatoa volcanic eruption in 1883, the dust clouds from which caused the average temperature in the USA to drop by a few degrees during the following year, giving widespread crop failures.

Modern manufacturing industries have become highly productive and efficient by consuming environmental resources on a far greater scale than ever before. But this same high productivity creates additional economic resources that can, if society so wishes, be used to protect and improve the environment. It is a problem for the future, which of these two opposing trends will win - either the consumption of environmental quality by industry or the preservation of quality by environmental improvement programs through the application of the additional resources being created by modern technology and economic

activity. Up till now, the economic resources for environmental improvement have usually been found when urgently required, but have rarely been satisfactorily provided except under dire threat of an environmental disaster.

2.3 Current Scenario

Before directing attention or other related issues, it is probably pertinent to discuss a few points (from the paper by A. Mookherjea [28]) about the current scenario in respect of certain elements of the environment such as air, water, etc.

2.3.1 Water Pollution

In our country comprehensive industrial documentation has been initiated with respect to the following eight industries in order to evolve the minimal National standards for liquid effluents;

1. Inorganic Chemicals
2. Organic Chemicals
3. Soda Ash
4. Pulp and Paper
5. Dyes
6. Paints
7. Natural Rubber
8. Tanneries

These will also include proper management of cooling water discharge which plays a significant role in the control of industrial water pollution. According to the Central Pollution Control Board problems have been encountered in implementing these standards for certain chloro-alkali industries, manmade fiber industries, fertilizer industries, oil refineries, pesticide industry, small scale paper and pulp industry and integrated iron and steel plants.

The Central Pollution control Board has undertaken extensive studies in connection with domestic water and sewage treatment plants. The biological oxygen demand of a number of treatment facilities

available in certain areas for sewage treatment. The findings suggest that there are a lot of areas where developmental work has to be carried out for upgrading the sewage treatment plants.

The waste from the industrial use can be organic or inorganic or a combination of both, as well as toxic. Some of them are readily bio-degradable like those from dairies, sugar industry, etc. some of them are partially degradable such as pulp mill, etc., while some of them are not biodegradable - toxics like polymer, etc. Considering the amount of water, which is needed to run these industries, it is obvious that an attempt must be made, so that part of the water utilized can be recycled and re-used. The result of suitable treatment will be the potential conservation of water resources, supplement irrigation and increase plant yield.

The cost of effluent treatment may vary because of mixing of different effluents, because of dilution of the pollutants, use of partial treatment, etc. The different methods might be divided into physical treatment, biological treatment, thermal treatment, chemical treatment and adsorption treatment. A lot of them even today are being practiced in India, but it is felt there is a lot more of these treatment processes ought to be adopted.

On the biological treatment extended aeration, activated sludge and plastic media bio-filters have been used with limited applications. So far as thermal treatment is concerned drying and evaporation has been utilized quite a lot, while the application of incineration has been tremendously limited. Each of these processes involves different types of equipment which has advantages and disadvantages; it is very necessary to pursue those with the proper application technology to

arrive at a cost effective solution for any particular process.

2.3.2 Air Pollution

The Central Pollution Control Board has recently taken over the task of evolving environmental regulations with reference to the following industries: Foundries, Caustic Soda, Petroleum, Chemicals, Pulp and Paper, Man-made Fibers and Asbestos. A task force was also constituted to persuade the Cement plants in the Country to implement the environment regulations. Similarly another task force was constituted for effective persuasion and monitoring of the thermal power industry. The same efforts are being carried out towards the iron and steel industry, fertilizer, etc. Minimum national standards have been prescribed for a number of other industries.

2.4 Environmental Costs

The traditional position, based on the old assumption that the environment is 'infinite' and free for all, which is no longer valid in crowded societies, has been for the polluter not to pay the cost of his consumption of environmental quality, in which case pollution is an external cost of his activities.

Environmental costs can take various forms which have been described by the US Council on Environmental Quality as damage costs, avoidance costs, transaction costs and abatement costs. Damage costs are the direct costs of pollution itself, e.g. the cost of bronchitis, etc. in people afflicted by smog, or the cost of fish losses due to poisonous effluent discharged into a river. Avoidance costs are those incurred by people in attempting to separate themselves from pollution, e.g. the cost of sound-proofing a home to keep out the noise. Both

damage and avoidance costs are external costs and they can be large. Transaction costs are the costs of gathering information about pollution, especially by monitoring, and of preparing and administering anti-pollution policies. Abatement costs, which usually dominate discussions of pollution economics, are those incurred in preventing or abating pollution, e.g. the cost of a sewage treatment plant.

2.5 Search for Optimum

There is a roughly inverse relation between damage and avoidance costs, on the one hand, and transaction and abatement costs, on the other. Where the latter are not charged, the former will run high, and vice versa. Somewhere between lies the optimum. The best return is not gained by trying to 'stop all pollution'. Indeed this is impossible. Chasing the last few atoms of mercury in edible fish, or of lead in city air, would cost an inordinate amount of money, which might have been put to other more beneficial uses. In a best use of resources, some pollution has to be accepted. Nor does the optimum necessarily lie any where near the point where expenditure on abatement is equal to the unabated external costs.

The difficulty in practice with this theory is that the costs and benefits are generally not easily measurable or even quantitatively definable. What is it worth, to see trees in blossom? Thus in practice, expenditure on pollution abatement has to be determined largely by intuitive judgments. Of course, where a serious emergency is caused, as for example the Bhopal incident, action to combat the pollution becomes imperative. Catastrophic pollution episode can also occur due to faults with systems meant for storage and transport, damage to off-shore installation, damage due to build-up, dangers due to toxic

waste, progressive contamination of soil around installations, accidental releases of chemicals to ground and surface water and environmental damage caused by noise. But in less extreme cases, it is usually a matter of judgment on social priorities whether to go on putting up with an existing unsatisfactory level of environmental quality or to spend an increased effort on improving it at the expense of forgoing opportunities to do other desirable things.

2.6 Legislative and Regulatory Trends Regarding Water and Air Pollution Control and Prevention

Legislation to control the environmental side effects of science and technology has gradually come into effect in India. Of course, some action was always possible in the earlier regulatory laws dealing with industry and post event penalty could be found under the Indian Penal Code. Yet a comprehensive legislation was lacking.

Of immediate concern is the control of pollution of air and water vital to the existence of animal and plant life both. This is now covered by the Water (Prevention and Control of Pollution) Act, 1974 and the Air (Prevention and Control of Pollution) Act, 1981. Even more basic is the concern to maintain the ecological balance and retain the natural environment inherited by us. The object of the recent Environment (Protection) Act, 1986 is precisely this. This section contains the salient features of above statutes [22,26] along with related important rules and regulations in brief.

2.6.1 The Water (Prevention and Control of Pollution) Act, 1974

This Act has been enacted by Parliament under Article 252 of the Constitution with a view to control the pollution of rivers and streams.

The Act is intended to ensure that the domestic and industrial effluents are not allowed to be discharged into water courses without adequate treatment. It has been adopted by almost all the States.

Provision was made **for the constitution of a Central Board** (under Section 3), **State Boards** (under Section 4) and **Joint Boards** (under Section 13) for the prevention and control of pollution.

2.6.1.1 Powers and Functions of Pollution Control Board

Central Board has to coordinate the activities of State Boards and resolve disputes among them. The main function of the State Boards are

(1) to lay down standards of pollution and

(2) to make consent order for putting trade and sewage effluents into the streams.

The Central Board, the State Boards have to act according to the directions of the Central Government and State Government/Central Board respectively. In cases of divergence in directions given by the State Government and the Central Board, the matter is to be referred to the Central Government for adjudication.

Provisions exist in the Act for appeal against the orders of the State Board to the appropriate authority constituted by the State Government. The State Government has been empowered to revise the orders of the State Board. Penalties are to be inflicted for contravening the standards laid down by the State Board and for violating the provisions relating to the consent of the Board. There is a provision for the State Board to apply to the court for restraining apprehended pollution of water.

The Boards have been empowered to investigate and inspect and to take samples. There are provisions in the Act for establishing the

Central Board laboratory and appointment of analysts. Further, State Boards have been vested with the powers to carry out themselves certain works relating to prevention and control for sewage and trade effluents. Rules may be framed by the Central Government for prohibition or regulation of bathing in any stream or well or washing or cleaning them or putting any objectionable matter therein, or regulating the use, on any stream, of vessels provided with sanitary appliances from which polluting matter passes into stream.

In a nutshell, the function of the Central Board is to coordinate the activities of the State Boards and thereby plan and execute a nationwide programme for the prevention, control and abatement of water pollution. The State Boards, in turn, will plan a comprehensive programme for the same purpose in their respective States.

Prohibition on use of stream or well for disposal of polluting matter, etc. are covered in Section 24 of the Act as follows:

(a) No person shall knowingly cause or permit any poisonous, noxious or polluting matter determined in accordance with such standards as may be laid down by the State Board to enter (whether directly or indirectly) into any stream or well; or

(b) No person shall knowingly cause or permit to enter into any stream any other matter which may tend, either directly or in combination with similar matters, to impede the proper flow of the water of the stream in a manner leading or likely to lead to a substantial aggravation of pollution due to other causes or of its consequences.

(3) The State Government may, after consultation with, or on the

recommendation of, the State Board, exempt, by notification in the Official Gazette, any person from the operation of sub-section (1) subject to such conditions, if any, as may be specified in the notification and any condition so specified may by a like notification be altered, varied or amended.

Section 25 of the Act (**Restrictions on New Outlets and New Discharges**) forbids bringing into use any new or altered outlet for the discharge of sewage effluent into any stream or well, without the previous consent of the State Board. For obtaining such consent, an application has to be made to the Board in the prescribed form with details of proposed disposal, its composition treatment, etc. The Board may make inquiries or inspect the factory with a view to working out conditions as to the temperature, volume, composition, rate of discharge into the stream etc. Specific time limit for compliance of conditions of consent has to be laid down. Usually, the consent is granted for a period of two years and thereafter it has to be renewed.

Section 26 of the Act has **provision regarding existing discharge of sewage or trade effluent**: "Where immediately before the commencement of this Act any person was discharging any sewage or trade effluent into a stream or well, the provisions of Section 25 shall, so far as may be, apply in relation to such person as they apply in relation to the person referred to in that section subject to the modification that the application for consent to be made under sub-section (2) of that section shall be made within a period of three months of the constitution of the State Board.

Under Section 33 of the Act, the **power of Board to make application to courts for restraining** apprehended **pollution of water in streams of**

wells is delineated: "(1) Where it is apprehended by a Board that the water in any stream or well is likely to be polluted by reason of the disposal of any matter therein or of any likely disposal of any matter therein, or otherwise, the Board may make an application to a court, not inferior to that of a Presidency Magistrate or a Magistrate of the first class, for restraining the person who is likely to cause such pollution from so causing.

Failure to comply with directions given in the Act **the penalties and procedures** are covered under Section 41 to 50. Important sections are reproduced below:

41. Failure to comply with directions under sub-section (2) or sub-section (3) of Section 20 (which deals with 'Powers to Obtain Information or orders issued under clause (c) of subsection (1) of Section 32- (1) Whoever fails to comply with any direction given under sub-section (2) or sub-section (3) of Section 20 within such time as may be specified in the direction or fails to comply with any orders issued under clause (c) of sub-section (1) of Section 32 shall, on conviction, be punishable with imprisonment for a term which may extend to three months or with fine which may extend to five thousand rupees or with both and in case the failure continues, with an additional fine which may extend to one thousand rupees for every day during which such failure continues after the conviction for the first such failure.

47. Offences by companies - (1) Where an offence under this Act has been committed by a company, every person who at the time the offence was committed was in charge of, and was responsible to

the company for the conduct of, the business of the company, as well as the company, shall be deemed to be guilty of the offence and shall be liable to be proceeded against and punished accordingly:

Provided that nothing contained in this sub-section shall render any such person liable to any punishment provided in this Act if he proves that the offence was committed without his knowledge or that he exercised all due diligence to prevent the commission of such offence.

(2) Notwithstanding anything contained in sub-section (1), where an offence under this Act has been committed by a company and it is proved that the offence has been committed with the consent or connivance of, or is attributable to any neglect on the part of, any director, manager, secretary or other officer of the company, such director, manager, secretary or other officer shall also be deemed to be guilty of that offence and shall be liable to be proceeded against and punished accordingly.

2.6.2 The Water (Prevention and control of Pollution) Cess Act, 1977

The Central Government and the State Government have to provide funds to the Central Board and State Boards for prevention and control of water pollution. It was therefore, proposed to levy a cess on local authorities which are entrusted with the duty of supplying water and on certain specified industries. The cess proposed to be levied would be on the basis of the water consumed by such local authorities and industries. The cess will be collected by the State Government concerned, paid to the Central Government, which will, after due appropriation, pay such sums of money as it may think fit to the Central

Board and the State Boards of pollution control.

A provision of **rebate** exists in the Act as follows (Under Section 7 of the Act): Where any person or local authority, liable to pay the cess under this Act, instals any plant for the treatment of sewage or trade effluent, such person or local authority shall, from such date as may be prescribed, be entitled to a rebate of seventy per cent of the cess payable by such person or, as the case may be, local authority.

2.6.3 Air (Prevention and Control of Pollution) Act, 1981

In the UN Conference on the Human Environment held in Stockholm in June 1972, in which India participated, decisions were taken to take appropriate steps for the preservation of the natural resources of the earth which, among other things, included the preservation of the quality of air and control of air pollution. The Government decided to implement these decisions of the said conference insofar as they relate to the preservation of the quality of air and control of air pollution. It was felt that there should be an integrated approach for tackling the environmental problems relating to pollution. It was therefore, proposed that the Central Board for the Prevention and Control of Water Pollution constituted under the Water (Prevention and Control of Pollution) Act, 1974, will also perform the functions of the Central Board (or State Board) for the Prevention and Control of Air Pollution. The main functions of the central Board (detailed under Sec. 16) shall be to devise means to improve the quality of air and to prevent, control or abate air pollution in the country. To meet the desired objects, the Board shall lay down the standards for the quality of air and establish the requisite laboratories. The State Board (Sec. 17 deals with functions of State Boards) shall lay down the standards of emission of

air pollutants into the atmosphere from industrial plants etc. The recognition and establishment of laboratories falls within the purview of the State Boards. Central Board and State Boards have to act under the directions of the Central Government and Central Board respectively (Section 18).

State Government has been empowered to declare air pollution control areas and to perform certain other acts relating thereto (Section 19). Prohibition on the use of any fuel which is likely to cause air pollution or of the appliances other than the approved ones or burning of any harmful material in the said areas, can be ordered by the State Governments.

An embargo has been placed on the operation of any industrial plant in air pollution control area without the previous consent of the State Board (Section 21). Procedure to be followed and the conditions subject to which such consent shall be granted have been laid herein.

Where the emission of any air pollutant into the atmosphere is in excess of the laid down standard or is apprehended to occur, the person incharge of that control area shall intimate that fact to the State Board and the prescribed authorities, who shall devise remedial measures to mitigate the emission (Sec. 23). The expenditure incurred thereon shall be recovered from the industry concerned.

Authorised persons may enter and inspect any place for the purpose of performance of the functions of the State Board and to ensure compliance of the provisions of the Act or rules framed thereunder (Setion 24). The provision of Code of Criminal Procedure, 1973 or the corresponding State law are applicable in the matter of search and seizure in the affected industry.

Penalties have been provided in the Act (Section 37) for contravention of any of its provisions, which may be imprisonment or fine or both depending on the gravity of the offence. Those companies committing any offence are equally liable. Where it is proved that the offence has been committed with the consent or connivance of any director or any other officer of the company, such director or officer shall be proceeded against. In the case of Government departments, the Head thereof shall be deemed to be guilty and punished accordingly (Section 40).

Cognizance of any offence shall be taken by a Court only on a complaint or after obtaining previous sanction of the State Board (Section 42). Metropolitan Magistrate or a Judicial Magistrate of the first class are only authorised to try any offence under the Act (Section 43).

2.6.4 The Environment (Protection) Act, 1986

Although, there were laws dealing directly or indirectly with several environmental matters, it was necessary to have a general legislation for environmental protection. Existing laws generally focussed on specific types of pollution or on speific categories of hazardous substances. Some major areas of environmental hazards were not covered. there also existed uncovered gaps in areas of major environmental hazards. There were inadequate linkages in handling matters of industrial and environmental safety. Control mechanisms to guard against slow, insidious build up of hazardous substances, especially new chemicals, in the environment were weak. Because of a multiplicity of regulatory agencies, there was need for an authority which can assume the lead role for studying, planning and implementing

long term requirements of environmental safety and to give direction to, and coordinate a system of speedy and adequate response to emergency situations threatening the environment.

In view of what has been stated above, there was urgent need for the enactment of a general legislation on environmental protection which inter alia, should enable coordination of activities of the various regulatory agencies, creation of an authority or authorities with adequate powers for environmental protection, regulation of discharge of environmental pollutants and handling of hazardous substances, speedy response in the event of accidents threatening environment and deterrent punishment to those who endanger human environment, safety and health.

Hence this Act - The Environment (Protection) Act, 1986 - was constituted and received assent of the President on May 23, 1986 and published in the Gazette of India, Extra, Part II, Section 1, dated 26th May, 1986.

CHAPTER III

DEVELOPMENT OF HYPOTHESIS

This part of the exploratory study is aimed at developing propositions which would investigate the factors that influence the time lag in decision making over the adoption and implementation stages of pollution control equipment adoption. There has been a tendency to view the problems associated with equipment adoption around one highly visible issue or with a one-factor predictive model. The concern over the impact of regulation and governmental intervention and the hardware aspects of the equipment are examples of this tendency. One purpose of this section is to make a modest attempt to overcome this tendency by developing various hypothesis/prepositions.

3.1 Potentially Researchable Questions

Since this section would deal with the investigation of those factors which impinge upon the successful adoption of (new) pollution control equipment, the potentially researchable question raised in this context follows:

> What are the various factors which significantly affect adoption of new equipment in commercial firms and what is the relative importance of these factors?

3.2 Approach to Proposition Development

Development of propositions for this research question was based on an analysis of the existing body of literature in the area of adoption.

The different steps outlined therein are not necessarily sequential in real life, nor can they be completely programmed. Information acquisition many times becomes accidental, which may be explained through sociological reasoning. The decision-making process involved in the adoption of an equipment depends greatly on the organizational, as well as the cognitive, limitations of the individual decision makers [23]. March and Simon [27] hypothesized that stimulus to generation and acceptance of new ideas is external. Failure to achieve the desired level of organizational performance through existing programs leads to the adoption behavior. The process of adoption in a organization has a synergetic effect on further adoption behavior in the future. Thus organizational culture and climate become important in explaining the adoption or non-adoption of an innovation in a particular situation.

We assumed that the decision of an equipment is basically an investment decision. The characteristic feature of an innovation decision vis-a-vis an ordinary routine investment decision is in the process of handling uncertainty. Organizations vary in that capability for handling uncertainty either by institutional arrangements or by member characteristics. Environmental factors, such as those arising due to government regulations, market factors, etc., will affect the cost/benefit at the probability of success of the desired result at the post-decision stage. Factors related to the technology such as its level of development, technical feasibility, etc., become important in evaluating the probability of success.

3.3 Potentially Testable Propositions - (a) Techno-Economic Factors

Adoption of pollution control equipment is a need-oriented phenomena and in stimulating it the techno-economic factors have a major

role.

Based on a study conducted by the National Planning Association in three industries, Myers [30] commented: '... I sense that crisis, opportunity and personal compulsiveness dominated rationality in the selection of project to work on.' Based on the previous studies, it was realized that the use of an equipment will depend upon how the equipment is related to some recognized need. The equipment may be related to a specific problem with which the organization is faced at a particular time, or may simply be connected generally with the operations of the company. Besides the degree of general and specific connections which the equipment has with the firm's existing operations, Radnor, Rubenstein and Tansik [33] have reported that the urgency of the problem to which the technology (equipment) is related will also have a significant effect upon a firm's willingness to adopt that equipment. This led to the proposition:

Proposition 1:

The degree of urgency of the problem to which the equipment was related will affect the degree of success of adoption.

Rogers [36] pointed out that the quality of information received from the source (of an equipment supplier/manufacturer) plays a critical role in the adoption behavior of potential adopter. If the equipment is complex and the potential adopter does not have technical sophistication, the information received from the source becomes more important. Our next proposition was:

Proposition 2:

The quality of information received from the source about the equipment will affect the degree of success of adoption.

The state of the maturity of the equipment to be adopted is another factor which may determine its successful adoption. One way of determining the maturity of an equipment offered (in this context) is to determine the amount of additional work/modification that would be required before the equipment could be used by the company. Analysis of previous research work shows that maturity would effect the adoption process. Therefore, we hypothesized:

Proposition 3:

Maturity of the equipment offered will affect the degree of success of adoption.

Radnor, Rubenstein and Tansik [33] have identified the availability of financial and personnel resources as another direct causal variable determining the degree of implementation of a new technological advancement. According to Stewart [42], management tends to be more conservative about incorporating new technology when the investment is large. Regarding the implementation of new technical ideas, Gibson [14] remarked: "when the potentialities of a new development are demonstrated, the decision to choose this as the basis for a course of action must be taken in the light of the investment in money, manpower and skill that must be made to prepare it for public use." Following Gibson's argument, adoption of pollution control equipment can be regarded as an economic decision and thus would be dependent upon the resources available. Rogers [36] has observed that the financial position of the potential user affects the adoption decision.

However, a firm's general financial position is not the only important factor determining its ability to mobilize its resources for the purpose of adoption. Within the context of organizational

conditions, one of the primary limitations upon an organization's ability to adopt new pollution control equipment to the absence of people with adequate technical knowledge and a broad enough technical view point to ensure the success of the adoption. Based on this, we hypothesized the following:

Proposition 4:

Availability of personnel to implement the equipment/technology will affect the degree of success of adoption.

Proposition 5:

Availability of financial resources to acquire the equipment will affect the degree of success of adoption.

3.4 Potentially Testable Propositions - (b) Organizational Factors

The extent of top management's involvement affects the adoption process in several ways - it influences the mechanisms of communication and coordination and the time pressure for completion of an adoption decision. It has been shown [33,39] that the availability of resources for implementation of new technology depends upon (a) top managements support for the project and (b) organizational and external environmental conditions. The implementation of a new idea often causes a disturbance in the firm's existing distribution of power; thus the support of top management becomes essential when top management action or pressure is needed to overcome the resistance to change on the part of various sub-units in the firm. We thus hypothesized that:

Proposition 6:

The degree of top management interest in the pollution control

equipment will affect the success of adoption.

The environment or "climate", within an organization can also have a significant effect on the organization's ability to adopt pollution control equipment. The research carried on by Carter and Williams [5] and Burns and Stalker [4] has indicated that different organizations provide different organizational environments and these environments in turn foster different types of responses to new ideas. Carter and Williams proposed the concept of "technical progressiveness" to define a firm's propensity to apply science and technology for commercial purposes.

According to Katz and Kahn [23] "the climate or the culture of the system reflects both the norms and the values of the formal system and their interpretation of the formal system. Organizational climate reflects also the history of internal and external struggles, the types of people the organization attracts, its processes and physical layout, the modes of communication and the exercise of authority within the system."

Other researchers have investigated the concept that organizations differ in providing adequate environmental arrangements to facilitate achievement of "organized efforts" to adopt new technology. The more open system has been characterized as the one which "encourages mutual influence among status levels, high job autonomy and opportunities for interaction beyond those required by the job". It was therefore hypothesized as follows:

Proposition 7:

The degree of success of adoption will be influenced by the dimensions of organizational climate of the adopting

organization.

3.5 Potentially Testable Propositions - (c) Equipment Attributes

A set of potential predictors for the success of adoption include six attributes of the equipment itself. The first attribute is initial cost. It was felt that cost (incurred by the adopting unit to either purchase or develop and implement) would affect directly the adoption decision. It was hypothesized that:

Proposition 8:

The cost of the equipment would effect the adoption decision.

The remaining five attributes were selected from Rogers and Shoemaker [36]. The complexity of an equipment is the decision unit's perception of how difficult it is to understand and use the equipment. The trialability of an equipment is the extent of experimenting or limited testing that is possible. The compatibility of an equipment is its consistency with the experiences and need of the adopting unit thereby refers to the ease of adapting the equipment by the adopting unit. Finally, observability is the degree to which the results of using the innovation are easily visible and easily communicated to others. It was hypothesized that:

Proposition 9:

The compatibility, trialability and observability of the equipment will directly affect the time taken for adoption and the complexity of the equipment would inversely affect it.

3.6 Potentially Testable Propositions - (d) Other Factors

Social approval refers to status gained in one's reference group,

"a non-financial aspect of reward" [13, p.445] as a function of adoption. Adoption of pollution control equipment has a lot of 'show value' attached to it which may at times form a favorable factor for adoption. The adoption improves the company's image as such adoption signifies the concern the company has for the environment, nearby community, employees, etc. Hence it was hypothesized that:

Proposition 10:

The possibility that pollution control equipment adoption would improve the company's image was a factor in facilitating adoption.

Regulation and governmental action are really two aspects of a broader government information dimension but there is little agreement or consistent evidence to support an inhibiting, neutral or facilitating impact of governmental intervention on adoption of pollution control equipment. Utterback, et al. [45, p.9] report a wide variance in the impact of regulatory constraint. Government intervention also would include actions such as providing information, procurement policy, tax policies (including incentives), patent policy, anti-trust policy, direct subsidy, grants and cost sharing [40] but the most important intervention is through the pressure of various pollution control Acts and Rules published in the Gazette of India from time to time.

Proposition 11:

The degree of success of adoption is affected by regulation and governmental action.

The last variable included here is the labor/union reaction to the pollution control equipment adoption under consideration. Labor/union resistance can effect the adoption decision and the success of adoption

in many ways, most important being their resistance can increase the interstage adoption decision time lags and/or the equipment may not function at the expected efficiency after its implementation.

Proposition 12:

Labor/Union co-operation will affect the degree of success of adoption.

CHAPTER IV

METHODOLOGY

4.1 Method of Study

To fulfill the aim of this study details about which has been outlined in the previous chapter the decision making process in the adoption of pollution control equipment in three industries was studied. The three industries - Pulp & Paper, Cement and Fertilizer - were selected because the environmental pollution was quite relevant in these three sectors.

Longitudinal observation is certainly a powerful and reliable method of studying strategic decision making processes, but it demands sizeable amount of research resource, because strategic decision processes typically span over periods of years. Hence we were obliged to study the process after completion, by interviewing the decision makers and key person(s) who played an active and crucial role in the adoption of pollution control equipment.

The best trace of the completed process remains in the mind of the key person(s) who carried it out. We made our best efforts to capture that trace of adoption process which still exists in the mind of the key person(s).

It is rather difficult to study a reasonable number of cases through personal interviews due to acute time constraint. Hence it was thought that a detailed questionnaire would prop up the sample size. A detailed questionnaire (enclosed in Appendix) consisting of three parts

was prepared and mailed to hundred organizations. Particulars about the firms in the relevant sectors were acquired from The Bombay Stock Exchange Official Directory and Indian Journal of Environmental Protection [19,20,21].

Based on the concentration of various industries one state - Andhra Pradesh - was selected for conducting field survey (personnel interview) primarily because of their locational advantage - entry into the organization, data collection, travel, etc. The rationale behind using interview schedule is that they would allow a structured probing yet not preclude flexibility (by utilizing a mix of fixed-alternative and open-ended questions) [38]. Furthermore, face-to-face discussion will allow the researcher an opportunity for taking the respondents back into the time of adoption decision and allow seeking the help of others who have been present during the adoption process.

Accordingly 40 firms were initially contacted by letter and on receiving favorable response were visited personally. This minimized the entree problems. In 8 firms - 3 from Pulp & Paper, 4 from Cement and 1 from Fertilizer Industry - the Chief Executive and the two key persons involved in the decision making process (Process Manager/ Project Manager/Maintenance Manager) were interviewed. In case of inconsistency in their response two more members from the middle or top management were further interviewed.

Out of the limited number of replies to mailed questionnaire received from different organizations we found that thirteen were of very good detail which we included in the final analysis.

We hope that this heterogeneity of the sample ensure a reliable

multi-dimensional insight into the decision making process in the adoption of pollution control equipment in Indian organizations.

4.2 Structure of the Inquiry

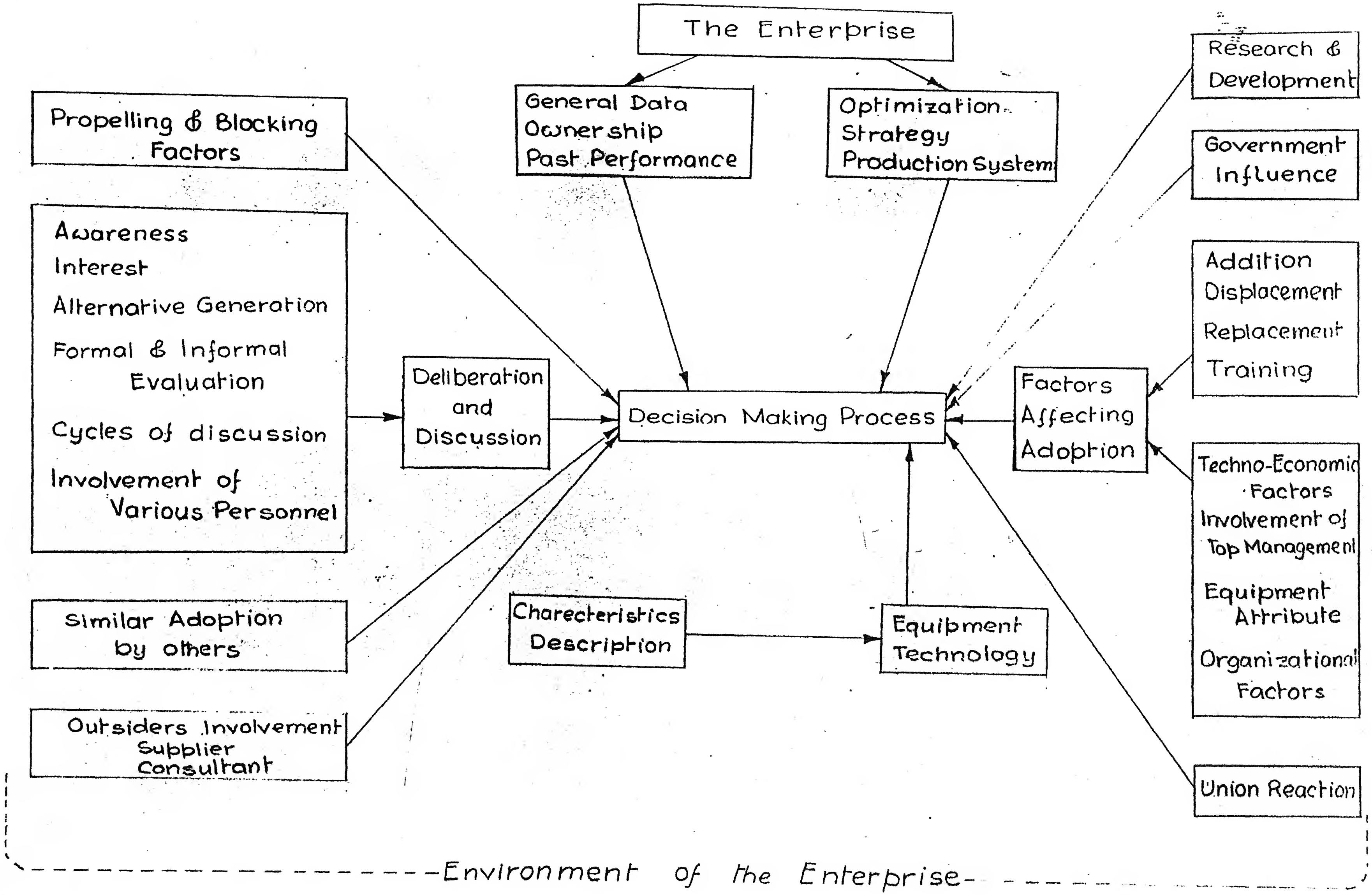
Considering the complexity involved in probing into the decision making process the inquiry was carefully structured after detailed study of the relevant literature [2,6,9,10,11,12,25,36,37]. A pictorial representation of the various factors probed in the inquiry questionnaire is shown in Fig. 4.1. The questionnaire consists of three parts - Part A, B and C.

Part A of the questionnaire was designed to elicit general information about the company, its performance, its organization and production process in brief. It also probed into the nature, characteristics and the description of the pollution control equipment. In addition to this, it contains questions on the influence of various techno-economic factors and equipment attributes, government interaction, union view etc. On the adoption process. (also refer Chapter III on Development of Hypothesis)

Part B of the questionnaire which was sent in five copies, to be filled by any five senior executives of the organization was aimed at assessing the organizational values - its adoption propensity, attitude to industry and social values. These instruments - Projective Test of Individual and Social Values [18], Attitude Towards Industry [7] and Adoption Propensity Scale [8] - were adapted from "Handbook of Psychological and Social Instruments" [32].

Part C of the questionnaire covers all the relevant points of an equipment adoption process. It specifically focus on the issues

Figure : 4.1 - THE STRUCTURE OF THE ENQUIRY QUESTIONAIRE



concerning awareness, interests evaluation, trial and adoption. It also attempts to elicit the various blocking and propelling factors (in order of priority) associated with the particular decision from the respondent.

CHAPTER V

CASE I : TWENTIETH CENTURY PAPERBOARDS COMPANY *

Twentieth Century Paperboards Company - the most ambitious paper and boards project in recent years - is situated near the bank of river Amba on a plot of 520 acres. Primarily set up to produce paperboard, it also manufactures maplitho due to various pressures of regulations. Although the financial picture of the Company has not been all that promising, it has established a record in operational efficiency - its labour productivity at 44 tonnes per annum per employee is nearly one and half times above the industry average and the 91% chemical recovery and 130% capacity utilization achieved are similarly well above industry average.

5.1 Organizational Decision Making

Decisions in Twentieth Century Paperboards Company are not made like that with a problem identified, an agreed approach to solve the problem applied and the solution dumbly accepted. According to the General Manager (Projects) of the Company "Decision making is much more complicated and complex than the normative models assume. Just because the linear programming model shows the cheapest solution or the discounted cash flow calculation gives the 'best buy', we are not going to do automatically as these studies recommend. This is because, to state the obvious, there are many other considerations involved in

---

* All names (of persons and places)have been disguised at the request of the persons interviewed.

organizational decision making, besides what is the cheapest or most profitable. Decision making in organizations should better be called organizational behaviour, because decision making has a calculated, purposive ring to it, while much of what happens is the result of no single person or group and results from 'conflict, confusion and compromises', so that it is often very difficult to say who was responsible."

5.2 Company Background

The Company was founded in 1975 as a part of the diversification plans of its present Company. The objectives were to help reduce the Nation's perennial paper shortage and locate the plant in a backward area. From 1st Oct. 1979 the Company has been in commercial production of paper and paperboards. These are mostly targeted to meet the manufacturing and packaging demands of the parent Company, which is a dominant producer of a consumer product. Tetrapack markets and the general paperboards market in Western and Southern India are also catered to. The Company has stabilized at a turnover of Rs. 54 crores with average annual net profit of Rs. 3 crores. The Company which has annual as well as extremely flexible very long term corporate plans (of 6 to 10 years) is seeking new technologies rapidly and the long term strategy of the company is to diversify into new lines of manufacture.

5.3 Becoming Aware of Pollution

After deciding about the establishment of the Company a core group was formed which was entrusted with the duty of indepth probing into various areas under the sole guidance of Mr. A.B. Ferris, the Vice Chairman of the parent Company. In collaboration with the Forest

Research Institute, Dehradun, the sulphate process was selected for pulp making. When discussions were almost at the final stage the Process Manager raised the issue of installing equipment(s) for pollution control which was vèhemently opposed by the Finance Manager under the plea that arranging for finance would be a problem, so it was deferred. Soon enquiries were addressed to the various equipment suppliers, contractors, process consultants, etc. for various equipment selection and erection.

5.4 Process Description (Paper Making)

Paper making operations (refer Fig. 5.1) involve extraction of cellulose fiber from raw materials, dressing and joining of fibres on paper machine to form a sheet which is subsequently dried and finished.

5.4.1 Extraction/Preparation of Fiber (Pulping)

Bamboo and hardwood are basic raw materials for paper making considered here, though bagasse, straw, hemp, waste paper, etc. are also used as raw materials by small medium size manufactures.

The primary cellulosic fiber in bamboo/hardwood is associated with non-paper making ingredients such as 'Lignin', and organic compound. The separation of pure cellulose from lignin and its dressing forms the first part of paper making.

The raw material is first mechanically cut into smaller pieces in chippers and is conveyed to the digesters (the digester is a large inverted conical steel structure with heating facility). The sulphate process (there are other processes also) calls for a shorter digestion period of about five to six hours, with a mixture of sodium sulphide, hydroxide, sulphate and corborate. The digester temperature is

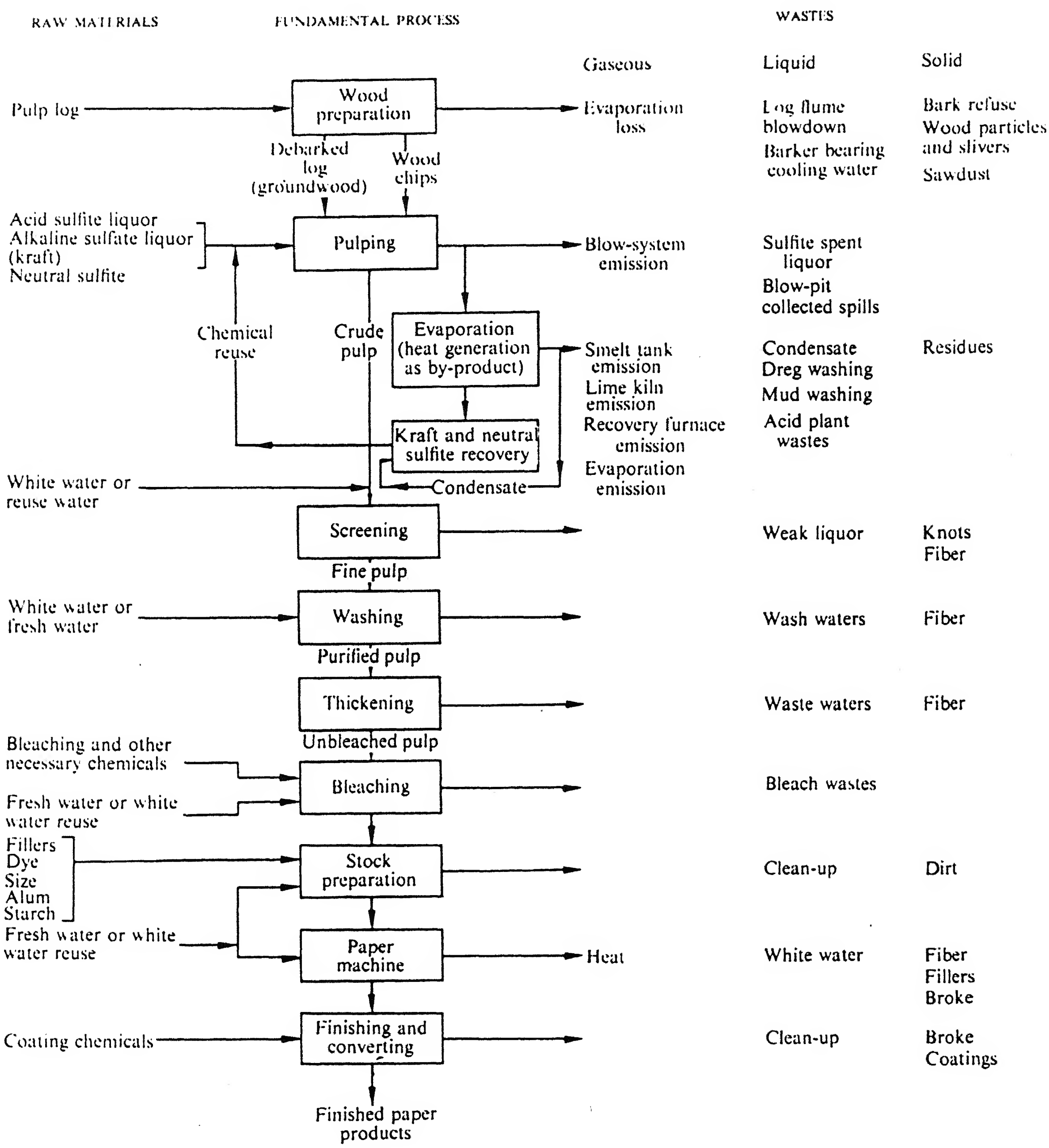


Fig. 5.1 : Simplified Diagram of Fundamental Pulp and Paper Processes

gradually raised and chips thoroughly cooked for 4 to 5 hours, to make a paste of bamboo/hardwood called pulp. The cooking solution reacts with lignin and separates it as out-going liquid. The pulp is now washed and cleansed to eliminate impurities.

At this stage the pulp is light brown in color. This can be used as it is to make paper. If white paper is required the pulp is bleached with chlorine gas and subsequently with hypo solution to impart whiteness and to eliminate dissolved impurities and lignin.

The white pulp from bleaching is then refined by mechanical action. Here the multiwall cellulose fiber gets cut to the required size and becomes soft with its end walls broken into brizles (fibrillation) leading to fiber-swelling by water absorption. Rosin and alum are added to improve fiber-bonding properly. This is called stock and the process stock preparation.

5.4.2 Paper Machine Part

The stock is dissolved in water at 0.5% fiber to water ratio. This is held in the head box.

The fiber-water from head box is jetted across an endless/continuously rotating wire-mesh (called fourdriner wire) which moves like a seive. The water is drained through the mesh by vacuum created underneath, leaving the fibers on the rectangular wire mesh to form a turbid mat. This mat is subsequently passed through a system of rotating rolls (pressers), to remove water in the mat by pressing action.

Here it is important to note that the swollen fibers from hydrogen bonds with each other in presence of water imparting strength to paper.

The wet sheet coming out of press section is passed through a

series of dryer-cylinders at gradually increasing temperature to further reduce water content in the sheet ending at 5 to 7 percent moisture. During the process the sheet is passed through size press containing solution of starch, clay, dyes, etc., to impart and improve surface properties (brightness, smoothness, etc.) as required. This is surface sizing, followed by calendering where in the sheet is passed through tangentially rotating steel rolls for improving smoothness and gloss.

The sheet is now paper.

5.4.3 Paper Finishing

The paper is reeled into a tamboor roll weighing 5 to 9 tonnes with a length of 300 - 400 cm. The big roll is cut into smaller rolls/sheets in the finishing house as per customer requirements, packed and stacked for shipping.

5.5 Waste Generation - Pulp and Paper Mill Wastes

The manufacture of paper can be divided into two phases: pulping the wood and making the final paper product. Two main wastes originate from paper making, namely pulp-mill and paper-mill wastes. Pulp-mill wastes come from grinding, digester cooking, washing, bleaching, thickening and defibering. These wastes contain sulfite liquor, fine pulp, bleaching chemicals, merceptans, sodium sulfides, carbonates and hydroxides, sizing, casein, clay, ink, dyes, waxes, grease, oils and fibers. Paper mill wastes originate in water which passes through the screen wires, showers and felts of the paper machines, beaters, regulating and mixing tanks and screens. The paper-machine wastes contain fine fibers, sizing, dye and other loading materials. Characteristics of the entire Company's wastes is given in Table 5.1.

Flow diagrams of kraft pulp manufacturing processes and water balances are given in Fig. 5.2 and 5.3 respectively.

5.6 Pollution Control

5.6.1 Initial Deliberations

In late 1970s complete paper mill waste treatment was still in its stages. It was decided that actual treatment plant would be installed only after exhaustive study of all other technological and non-technological possibilities, since the cost of treatment is considered high in relation to the cost of the product produced. Thus, economic limitations forced the management to place emphasis on recovery rather than treatment.

Table 5.1: Characteristics of Mill Wastes

	Maximum	Minimum	Average
pH	9.5	7.6	8.2
Total alkalinity, ppm	300	100	175
Phenolphthalein alkalinity, ppm	50	0	0
Total solids, ppm	2000	800	1200
Volatile solids, %	75	60	65
Total suspended solids, ppm	300	75	150
BOD, 5-day, ppm	350	100	175
Color, ppm	500	100	250

5.6.2 Information Sources

Mr. Paul, a young engineer with post-graduate qualification in Environmental Engineering from National Productivity Council was

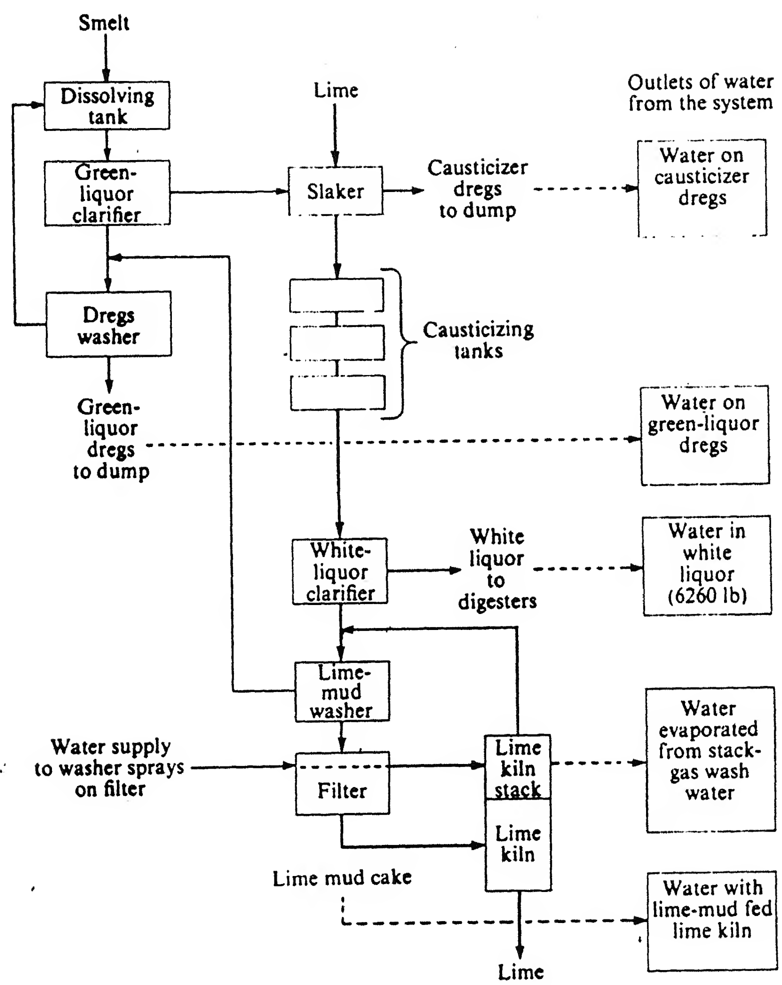


Fig. 5.2.: Flow Process Diagram of Kraft Pulp Manufacturing Process.

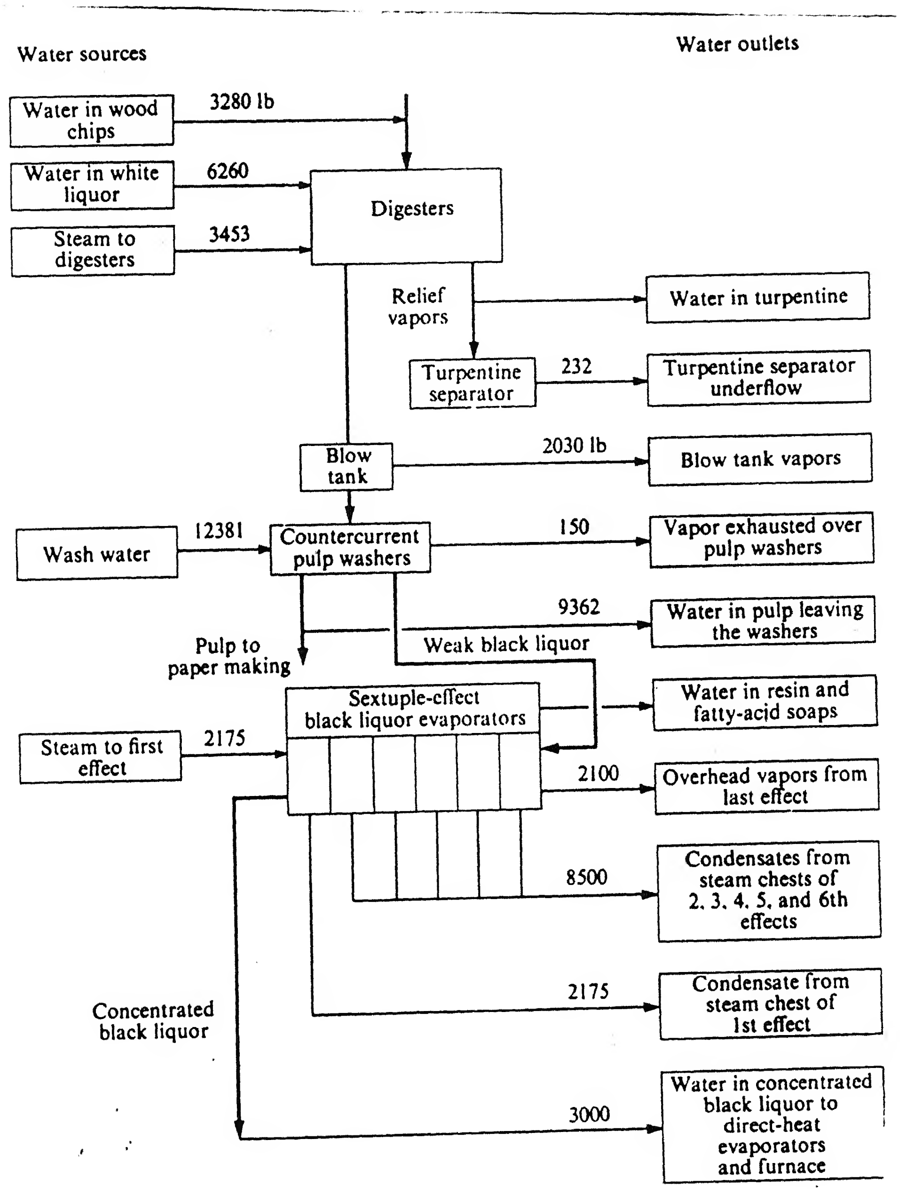


Fig. 5.3 : Water Balance (quantities in lb/ton of air-dry pulp)

recruited by the Company in the later half of 1976 mainly to head the pollution control and energy conservation section within the R & D group headed by Manager (Technical). He collected information on statutory requirement and various ways of combating pollution mostly from technical journals, personal correspondence (which also included correspondence with many reputed Indian as well as foreign pulp and paper waste treatment equipment manufacturers) and by attending conferences. Most of the similar pulp and paper industries were quite hostile in parting with information on techniques being used in their plant(s). So the only way by which he became aware of such adoption was through success stories/cases reported in journals, handbooks and conferences (Indian Pulp and Paper Manufacturers Association), although they were by no means detailed and care was always taken to conceal the critical aspects of the project.

5.6.3 Initial Proposal

Mr. Paul initially proposed (in mid 1977 while the erection of pulp mill was almost completed) the pulp and paper-mill wastes be treated in the following sequential manner: (1) Recovery and (2) Sand bag filtration in river Amba.

5.6.3.1 Recovery Process

The black liquor (spent cooking liquor) would be processed by evaporation and incineration, in order to recover chemicals and to utilize the heating value of the dissolved wood substance. During the recovery process, sodium sulphate, with added sulphur, would be added to replace the relatively small proportion of chemicals lost in the various steps of the process. Following these additions and the incineration, the smelt would be dissolved in water to form "green liquor". The

chemical compounds in the green liquor should be converted to the desired cooking chemicals by the addition of lime, so as to form of "white liquor" and a lime mud consisting chiefly of calcium carbonate. The white liquor would be returned to the pulping operation as the cooking liquor and the lime mud would be calcined to form calcium oxide, which would be reused in converting other green liquor to white liquor. By product recovery of terpentine, resin and fatty acids would also aid in reducing the strength of waste-water effluent. Maximum recovery of these by-products may result in effluent in which chemical toxicants are no longer significant factor, as for as stream pollution is concerned. The terpentine may be recovered from the digester relief gases, which also contain small quantities of methyl sulphide, dimethyl sulphide, methyl merceptan and ketones. It was also mentioned that the black liquor also contains recoverable quantities of sodium salts, resins, and fatty acids, which would be separated during the concentration and cooking of the black liquor.

The recovery processes proposed was that practiced in other similar mills and it was suggested that suitable modifications might be made to suit its adoption by the Company.

5.6.3.2 Sand Bag Filtration

Effluent from the recovery process would be subjected to sand bag filtration in river Amba (refer Fig. 5.4). This was an was an innovative suggestion in which he (Mr. Paul) proposed that the effluent be directly disposed into a big cavity made in the near by river with the help of sand bags. The effluent would filter out through the sand bags slowly and mix with the stream. Once in a year during the monsoon when the flow is very high and the river is flooded with water all the

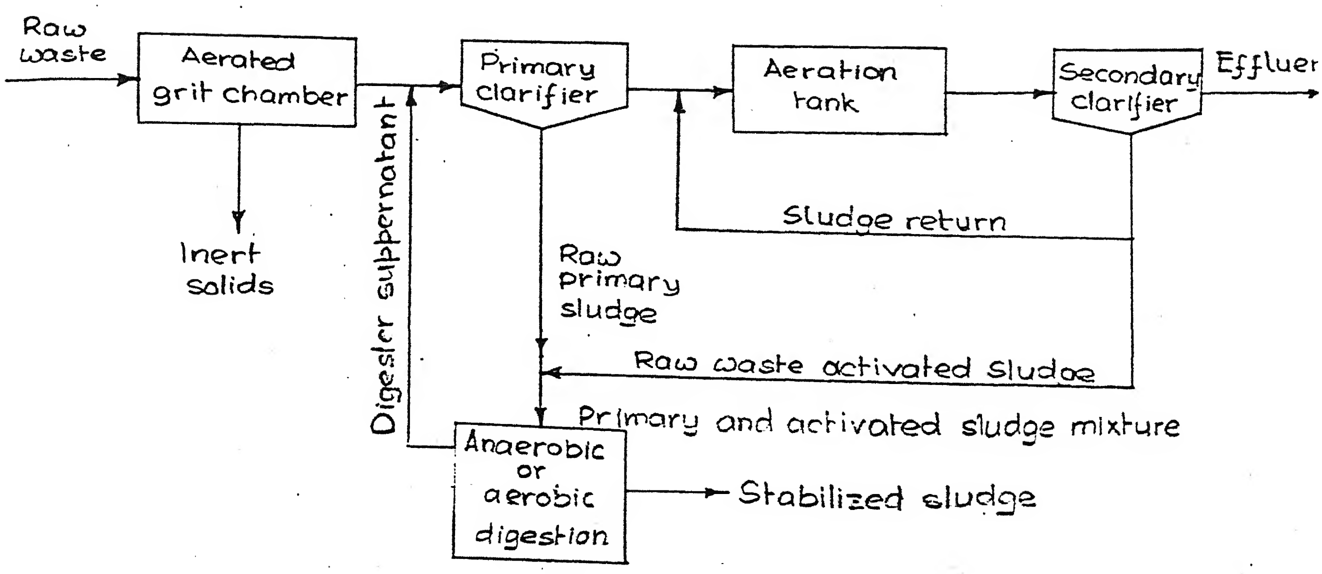


FIG.- 5.5: Flow Diagram for an Activated Sludge Treatment Plant

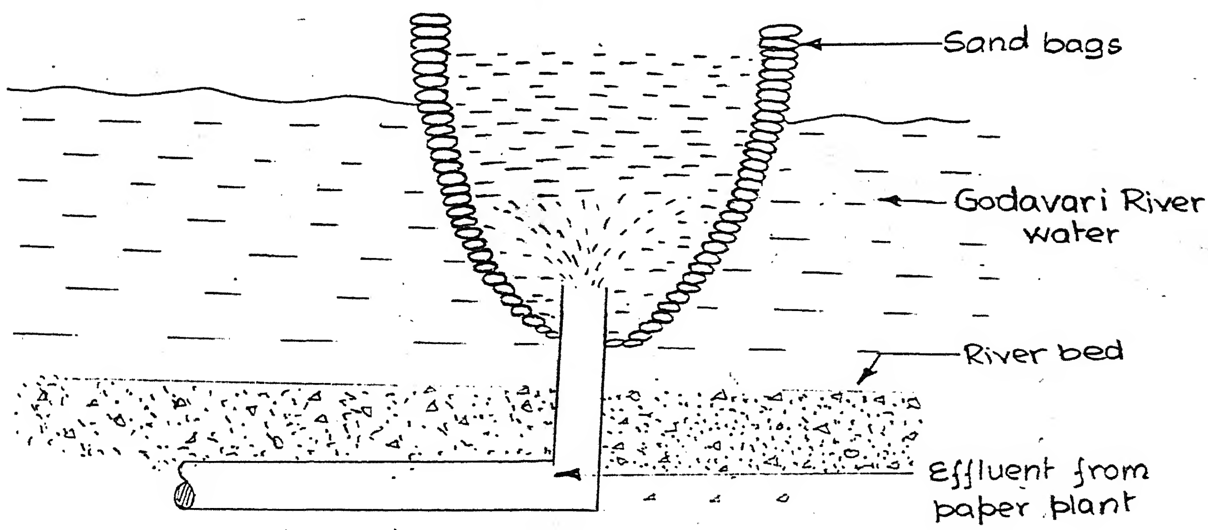


FIG.- 5.4: Sand Bag Filtration in River Godavari

contents in the cavity would be washed off and it would be ready to receive fresh affluent again.

5.6.4 Informal Discussion

Before presenting the proposal to the top executives, Mr. Paul thought it would be better to talk to the Project Manager with whom Mr. Paul had a good personal relationship. After reviewing the proposal the Project Manager advised Mr. Paul to talk to the local authorities and local people and get some information about the river flow characteristics which would make the proposal much more authentic.

5.6.5 Management Meeting

Two weeks later during the management meeting the proposal was presented. The recovery process was very much attractive but there were several managers (viz. Process Manager, Manager Design and Development, and Manager Finance) who were not ready to accept the second stage i.e., sand bag filtration technique. Although both Mr. Paul and the Project Manager tried to point out that it was the cheapest method to use based on initial cost and operating cost, the discussion remained inconclusive.

A young chemical engineer identified a few more alternatives to sand bag filteration (during the same meeting). He enjoyed a good reputation among the managers because of a few innovative modifications he had implemented in the plant. The choice for the second stage then seemed to narrow down to the following:

i) Burn the waste liquor to produce enough steam to run the evaporator/generator,

ii) Fermentation of the liquor to produce alcohol,

iii) Complete evaporation of the liquor to produce a fuel and/or a salable by-product.

In discussing these alternatives, as the meeting continued, the Manager Design and Development and his colleagues identified a variety of concerns. Of course cost was a major issue, but beyond that the alternatives would impact other areas of the plant. Each of the alternatives seemed to relate to the concern of the managers in different ways. The first alternative would call for fresh equipment design and more work for the Design and Development personnel. About the third alternative the Process Manager pointed out that although from the waste generated, some salable by-products could be produced, the main problem associated with the by-products was that the Indian market would not be able to absorb them. The other issue was: who would take up the responsibility of marketing the by-products? The Marketing Manager picking up the cue said that the limited number of marketing personnel in his department would make it impossible to take up further marketing of any new products.

While evaluating the second alternative the Chief Chemist pointed out that from his experience he was aware of the fact that it would be a costly affair. Moreover, the economics of these plants were somewhat uncertain due to lack of relevant operating experience and the limited availability of government grants to off-set some of the capital costs.

At this critical juncture the Finance Manager interrupted to say that they had discussed enough on the problem and they should discuss a bit about other more pressing problems. Taking the permission of the house he suggested that it would be best if this decision is left to Mr. Paul and his assistants and a few Senior Managers can discuss the final

proposal when it comes to them for ratification.

5.6.6 Second Round of Deliberation

Soon after this Mr. Paul coupled up with Mr. Robert Brown, the young chemical engineer and after many discussions with different people came up with a standard method (arrived at after discussions with an Indian equipment supplying Company about the reliability, applicability and maturity of the equipments supplied by them) of waste treatment which in addition to recovery would be treated in the following manner: (1) sedimentation and flotation to remove suspended matter, (2) chemical precipitation to remove color and (3) activated sludge process to remove oxygen demanding matter (details follow). The primary criteria of selecting the process was that it was a proven process and had been subjected to extensive testing. Moreover, there were manufacturers who claimed that they were ready to deliver full-scale plants.

5.6.6.1 Activated Sludge Process (ASP)

The activated sludge process is capable of converting most organic wastes to most stable inorganic forms or to cellular mass. In this process much of the soluble and colloidal organic material remaining after primary sedimentation is metabolized by a diverse group of micro-organisms to carbon dioxide and water. At the same time, a sizeable fraction is converted to cellular mass that can be separated from the waste flow by gravity sedimentation.

Activated sludge is a heterogeneous microbial culture composed mostly of bacteria, protozoa, rotifers and fungi. However, it is the bacteria which are responsible for assimilating most of the organic material, whereas the protozoa and rotifers are important in removing the dispersed bacteria that otherwise would escape in the plant

effluent.

After separating the liquid phase from the solid phases the biomass increase resulting from synthesis during substrata utilization is wasted and the remainder returned to the aeration tank. Thus, a relatively constant mass of micro-organisms is maintained in the system and performance of the process depends on the recycle of sufficient biomass. If biomass separation and concentration fails, the entire process fails.

5.6.6.2 Flow Scheme

The flow scheme for a typical activated sludge plant is presented in Fig. 5.5. In general, this process may be considered to be one that involves (1) waste water aeration in the presence of a microbial suspension, (2) solids liquid separation following aeration, (3) discharge of clarified effluent and (4) wasting of excess biomass and return of the remaining biomass to the aeration tank.

5.6.7 Another Proposal

The final proposal that was forwarded for ratification (around October 1977 while test runs of the various sections were being carried out) mentioned the details of the process which would be adopted, the basis of selection along with the distinctive arrays of benefits and burdens its adoption would offer to the Company. It also explicitly mentioned the potential burdens and potential risks associated with the above process adoption along with the initial cost and the operating cost of the process.

In the annual review meeting the proposal was presented. The manager who chaired the meeting did not think that the proposal should be discussed at length because there were other much more urgent problems - there was problem in commissioning the paper machine, project

costs had much exceeded the target and the plant was not running in full capacity.

The proposal was studied later and after a series of recommendations from various head of departments was forwarded to Mr. A.B. Ferris, the Managing Director.

5.6.8 Managing Director's Involvement

The Managing Director turned down the proposal without giving any explicit reason and attached a note which said that it would get due consideration at an appropriate time. It was difficult for people to comprehend what was it that impelled the Managing Director to take such a decision. At least Mr. Paul was very much disappointed.

Six months later, in 1978, while the commercial production commenced, a special circular was issued by the Managing Director along with a letter to Mr. Paul in which he showed concern for environmental protection. He emphatically stated that every one should endeavour to make Twentieth Century Paperboards Company, a model company in every respect and give pollution control a high priority. The old proposal was again moved by Mr. Paul, who was now in high spirits.

5.6.9 Final Acceptance

The Managing Director accepted the proposal and getting the required amount of money for the project was no problem at all. The detail plan was worked out in consultation with the Project Manager. Reliable equipment suppliers (with reputed foreign collaborators) were selected and soon various negotiations were settled and the effluent treatment plant was established September 1981.

5.7 Award Received

In 1983 the Company received an award for Establishment of Excellent Effluent Treatment Plant from the State Pollution Control Board. Today everyone is quite satisfied about the 'effluent treatment decision' because the 1983 award boosted up not only the morale of the Company personnel but also the Company's image.

CHAPTER VI

CASE II: ABC CEMENT COMPANY *

At first it was mainly the dust nuisance and the losses of material that occurred during the the grinding and packing of cement that prompted the ABC Cement Company to decide to replace the original Bag Filters by Electrostatic Precipitators (ESP).

6.1 The Company

ABC Cement Company is an old - established company located near Tandup railway station in Karanpur district of Andhra Pradesh which has for nearly twenty five years specialized in the manufacture of Portland and other types of cement and asbestos.

6.1.1 History

The Company was incorporated as a private limited company in 1962 and obtained the Certificate of Commencement of Business in 1965. A mining lease covering 1,892 acres was granted to the Company. A few years later the Company acquired another 700 acres of leasehold/freehold lands from State Government/private parties.

The Company has gone through a number of organizational changes over the last twenty five years and also several changes in management. There has been little attempt to make any radical change to the product range or even to expand the present market. One big advantage over its competitors has been its own marketing force of salesmen who are able to

---

* All names have been disguised at the Request of the persons interviewed.

maintain a regular contact with many of their customers and the Company has a good reputation for meeting its delivery schedules.

6.1.2 Collaboration

The Company entered into technical agreement with F.L.Smidth and Company A/S, Copenhagen, a designer and manufacturer of cement plants, its associates, F.L.Smidth and Cia. Espanole S.A., Madrid and with an Indian Company in Bombay for the supply of plant, equipment and services for the proposed project. Under the agreement the foreign Companies agreed to supply a major portion of the main plant and the Indian Company the rest.

6.1.3 Operation

In the last few years the Company has gone through many ups and downs. From 1977 - 79, production and despatches were considerably low due to prolonged labor unrest, problems of power supply, power restriction and voltage fluctuations. In 1979 - 80, the capacity utilization improved to 75.35% from 41.62% in the previous year. In 1981 - 1982, the capacity utilization increased further to 79.6%. Higher retention prices and partial decontrol of cement from 28th February, 1982 helped to improve the financial position of the Company. In 1982 - 83, the Company could not operate at the previous year's level due to frequent machinery breakdowns and repairs. In 1983 - 84, production was better than the previous year with a capacity utilization of 81.37%. Government granted an increase of Rs. 40 per ton in the retention price of cement with effect from 18th July, 1984. Cost of production, however, went up by Rs. 50 per ton consequent to an increase in the Mineral Rights Tax from Rs. 4.50 to Rs. 40.50 per ton by Government of Andhra Pradesh with effect from 13th January, 1984. For

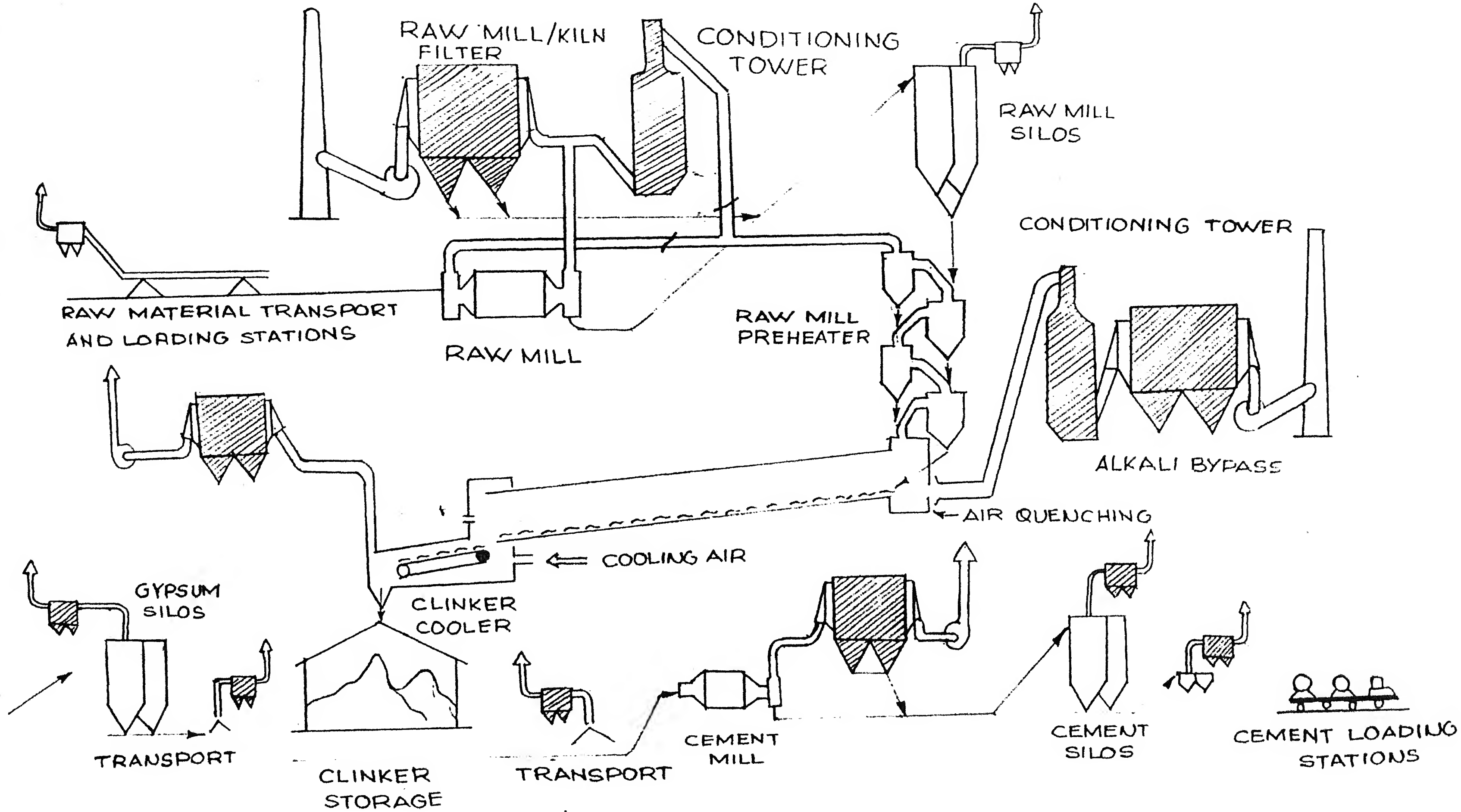
the next few years the Company devoted its attention to major repair/maintenance/replacement works which was financed through soft loans and through internal accruals. All these explain the wide variation in sales and profit figures of the Company in recent years.

6.2 Method of Cement Manufacture (Dry Process)

In rough outline the manufacture of cement in the plant consists of mixing the calcareous (those which supply lime) and argillaceous (those which supply silica, iron oxide and alumina) together intimately and heating them to the point of incipient fusion. Raw materials are quarried, ground, mixed and blended by the dry process, thus removing all the moisture from the raw materials. The raw materials are introduced into a rotary kiln which is fired with coal to produce a temperature of about 2500 F, when a sintering or semi-fusion takes place and the mixture rolls up into little balls varying in size from that of a walnut down to that of wheat, with an occasional large piece and some fine sand. Drying, decarbonating and calcinating are accomplished as the material passes through the kiln. After cooling, these lumps or "clinkers" are mixed with a small amount (2-3 percent) of the gypsum and finely pulverized. The resulting powder is bagged for shipment as cement. A typical layout for the Dry Cement Process showing only the mills and the kiln is shown in Fig. 6.1.

6.3 Air Pollution due to Cement Production

The 'classic' factor of environmental protection in the cement industry is the prevention of air pollution by suppression of the emission of pollutant matter into the atmosphere. In the dry process, some time the moisture removal is accomplished by passing large volumes



DRY CEMENT PROCESS

Fig. - 6.1

of heated air through the system. The dust entrained if not successfully collected is discharged to the atmosphere.

Another source of dust pollution is due to leakage of air from the clinker cooling and grinding equipment to the immediate environment. Cleaning the exhaust air discharged by the clinker cooler constitutes one of the biggest problems in connection with air pollution prevention. The exhaust air temperature of a grate cooler which under normal operating conditions is around 250 C, may vary within a range from 100 - 500 C; the dust content and the dust fineness in the raw gas downstream of the cooler likewise liable to vary within wide limits in consequence of disturbances in the kiln running and of irregularities in raw material composition.

A major source of dust, second only to the kiln exit gas, is the exhaust air discharged from the grate cooler. Waste gases from the rotary kiln constitute the major gas-cleaning problem of the cement industry. Normally from 3 to 5 percent of the raw material is carried away in the exit gases of the kiln as dust and fumes. The waste gases leaving the kiln has temperatures ranging from 400 to 1600 F and a dust loading ranging from 2 to 10 grains/cu.ft.

6.4 Bag Filters and Electrostatic Precipitators

In ABC Cement Company, Electrostatic Precipitators (details follow) have replaced the original Bag Filters mainly because the management of the Company noted the development of Electrostatic Precipitators (ESP) in the Country and their virtual maintenance free operation. As against this, the Bag Filter projected an image of highly maintenance intensive unit not so much because of any deficiency in the Fabric Filter

technology but mainly because (a) suitable fabrics for various types of operation have yet to be developed in the country and (b) due to reasons of space and economy, these Bag Filters - most of low ratio type - has a high loading i.e. high filtration velocity requiring very quick replacement of bags. The recovery value of the material, in the cement mill is considered to be of much more importance, than the control of air pollution. For the raw mill the company uses the same ESP as for the kiln.

6.5 Electrostatic Precipatator

An Electrostatic Precipitator separates entrained particulate matter from a gas stream by first charging the dust to a negative voltage of about 40,000 V, precipitating it onto grounded collecting electrodes, then dropping the agglomerated dust into a hopper. Despite high voltage used, energy consumption is low.

The flue gases pass in stream-line flow through earthed vertical tubes in parallel, in each of which is a central charged wire. Ionized gas molecules, travelling at high velocity between wire and tube, collide with the particles in the gas stream and these, too, become electrically charged. Those that are negatively charged are driven to the earthed tube where they stick. When the tubes are jolted by the vibrator rapping gear, the particles, now coagulated into larger aggregates, escape against the flow of the gas stream while keeping near the walls of the tubes, into hoppers. Those particles which are at first positively charged are driven to the central wires from which they are released by the rapping of the wires. They have now the same charges as the wires, namely -40,000 V, and they immediately join the

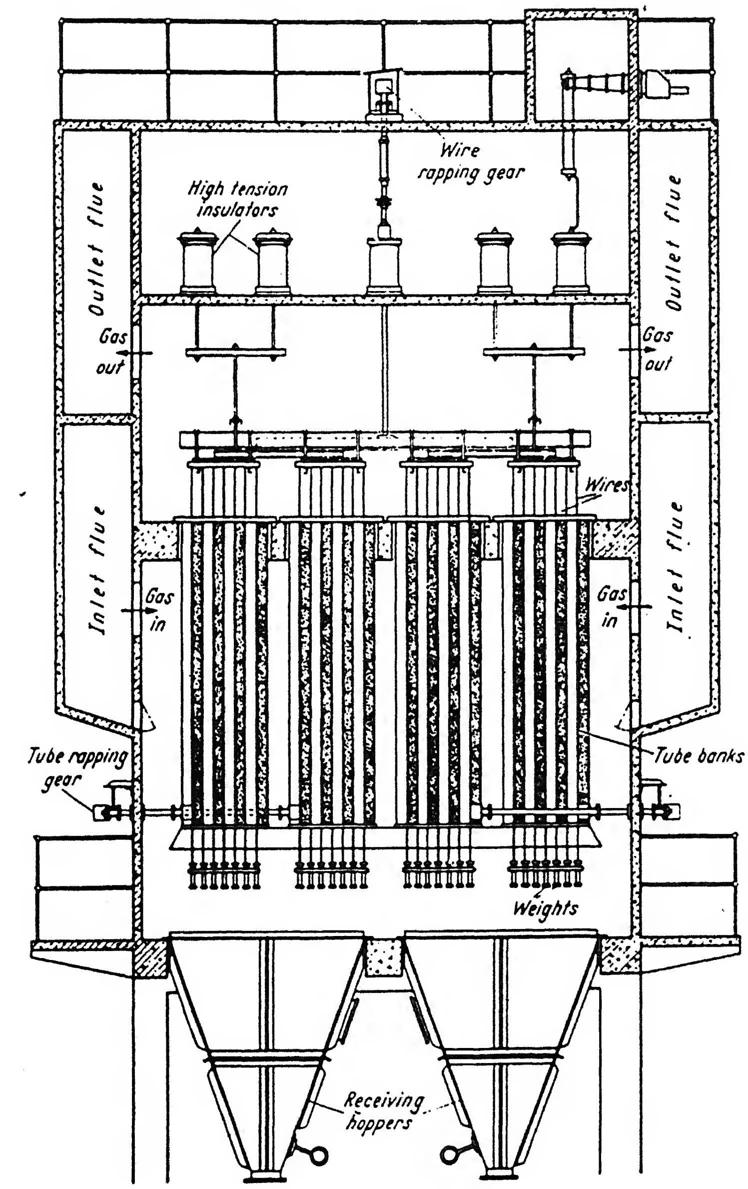


Fig. 6.2 : Electrostatic Precipitator (ESP)

other negatively charged particles in their migration to the earthed tubes.

ESPs are capable in practice of removing 95-99 percent of the weight of dust from flue gases; they are rather more effective for removing mineral dust than carbonaceous dust such as particles of partly burnt coal. Kindly refer Fig. 6.2 for details.

6.6 Initial Installations

During the project stage of the Company the risk of polluting the air by dust was realized. Particles of ash and grit emitted from chimney would pollute the environment. To reduce the threat to pollution, the then Project Manager laid emphasis on two factors during the selection of the plant.

1. The velocity of the gases in the flues and the stack should be low, so as not to carry the dust particles.
2. The emission of dust should be reduced by proper selection of the fuel and by proper design of the fuel burning equipment.

The wet process of cement manufacture which has lower level of dust emission was however not selected due to financial constraints.

In accordance with the Company's policy of giving priority to clean environment, during the commissioning of the plant in 1958, dust arresters (Pulse Jet Bag Filters and Reverse Jet Fabric Dust Collector) were installed. Kindly refer Fig. 6.3 and 6.4 for details of the initial installations. The units installed answered the need for a low cost, compact, constant volume fabric dust collector. It should be noted that there was no Government regulations yet.

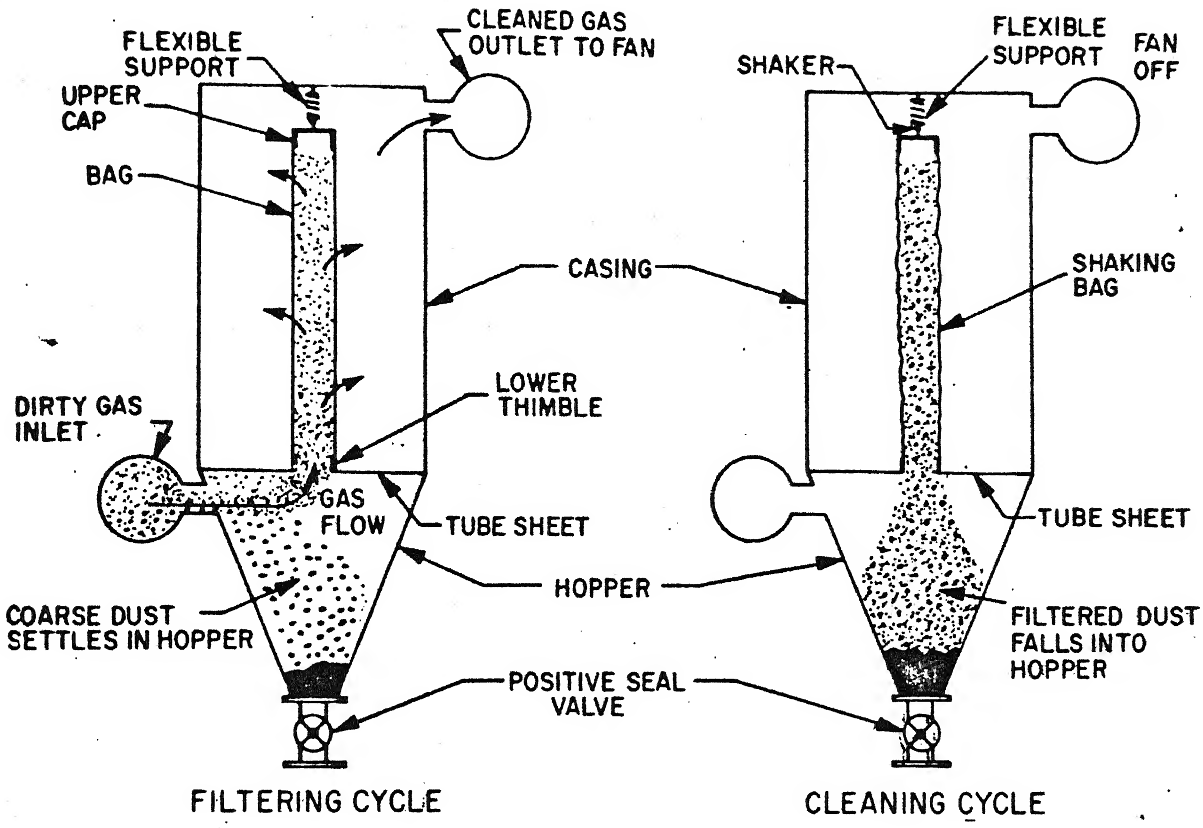


Fig. 6.3: Fabric Bag Filter.

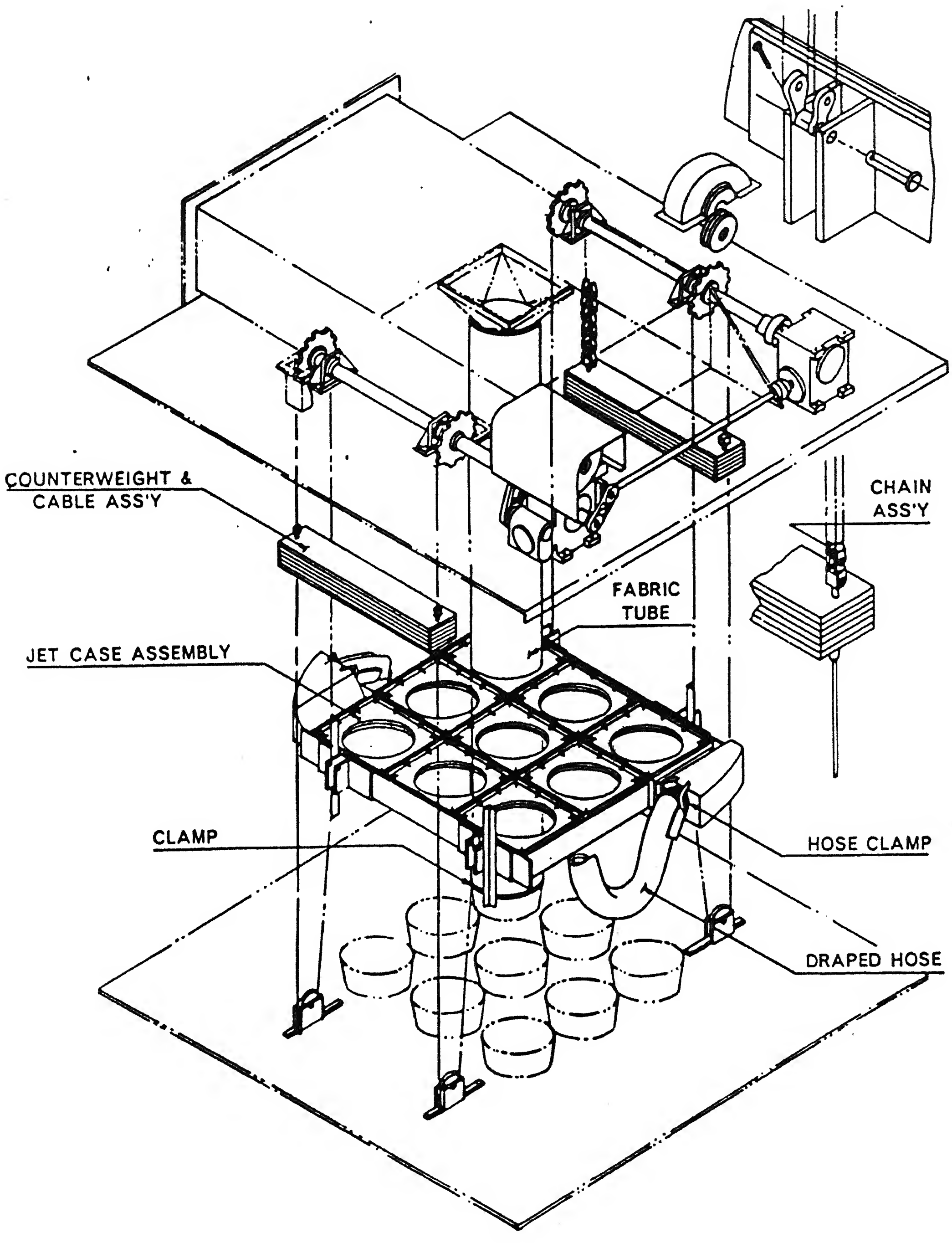


Fig. 6.4 : Reverse Jet Bag Filter

6.7 Initial Complaints

Soon after the production started and the plant started producing at the rated capacity (500 tons/kiln/day x 2) the ineffectiveness of the initial dust control equipment became evident. People of the nearby locality while seeing the air always noticed the increased particulate load most easily because of the great power of absorbing and scattering light. People who had cause to complain could usually indicate with some certainty the place of origin. The nearby thermal power plant also had similar complaints. The environmental issues were becoming increasingly more important. Although there were other groups of people which tended to discount the environmental concerns as a fad and felt that the concern was due to psychological reasons.

6.8 Company's Response

Such complaints were usually not taken seriously by the company and they were kept off the record. Describing the situation prevailing then the Industrial Engineer of the Company Mr. S.A. Khan commented "In the absence of strong compulsive force of legislation, the degree of dust control had to be determined by the cost to the Company balanced against benefits to the general public, a decision largely forced by public (mostly plant workers and poor villagers) concern about their health and their environment together with the concern about the health of its employees.

6.9 Information Sources

Meanwhile the process and maintenance department personnel kept themselves informed about the various effective ways of dust control in various sections of cement plant, mainly through the various equipment

supplier's technical literature and journals. The meetings with the Development Commissioner of Cement Industry and the conferences sponsored by the National Council for Cement and Building Materials helped in creating not only a sound foundation about the effectiveness and ways of designing an effective air management system but also created awareness as to how other similar industries were tackling the problem.

6.10 Initial Proposal

The Vice President (Technical) in the annual performance review meeting in 1980 raised the issue of effective dust control. Soon two other managers (process and maintenance) proposed various alternatives based on the knowledge they had gathered from conferences. They also discussed for a short while the priority given to dust control by other similar plants. During the concluding session of the meeting the Vice President (Technical) made it clear that due attention to dust control should be paid otherwise they would probably be forced to follow a time bound program under the directive from the Pollution Control Board. The most knowledgeable person - the process manager - was given the task of preparing a proposal after detailed discussions.

6.11 Detailed Discussions

The detailed study was performed by a group comprising of the Process Manager, the Maintenance Manager, the Industrial Engineer and the Plant Engineer. While discussions were in progress about the equipment to be chosen the various limitations were pointed out. Few of them are mentioned below:

i) "Settling chambers and cyclones are basically low efficiency

separations, which can remove large size particles, at high dust loadings. For these reasons, they could be effectively used as pre-cleaners."

ii) "Bag filters are effective control device for removing sub-micron particles. However, they must be utilized at temperatures less than 500 F, depending on the filter material, and at definite filtering velocities, to prevent destruction of the bags."

iii) "Wet collectors or gas scrubbers are capable of removing both particles and vapors from an air stream. However, when used for hot exhausts, a visible stream plume is often emitted as reported by other similar industrial adoption(s), which could create a nuisance. In addition, the contaminants are discharged in a liquid blow down stream, requiring suitable waste treatment disposal facilities."

iv) "Electrostatic precipitators are also effective in removing sub-micron particles, but they are sensitive to varying flow conditions and particle loading. A change from design conditions could drastically reduce collection efficiency. Instrumentation to adjust for varying conditions is generally expensive."

Different persons having different concepts and ideas, produced different alternatives.

In April 1980, the industrial engineer was given the responsibility of making outline of the formal proposal which in addition to evaluating the various alternatives proposed would also mention the list of burdens and risks along with economic aspect of the implementation of the equipment which would be again discussed and then signed by the group

members before forwarding it to the higher management (Vice President (Technical)).

6.12 Final Proposal Making

The final proposal which was prepared,in October 1980, after many informal discussions with various knowledgeable persons and also the marketing personnel of reputed manufacturers mentioned two potential burdens - displacement of undepreciated asset (Bag Filters) and need for new investment funds (of about Rs. one crore). The potential risk mentioned was that the equipment won't function acceptably if the maintenance department were not very efficient in learning the various aspects of the equipment. The profitability of the adoption decision was also clarified. The implementation of the dust control equipment would lead to recovery of cement dust which could be recycled and also some amount of energy (in grinding) would be saved. The proposal was signed by all and forwarded to the higher management.

6.13 Pollution Control Boards' Intervention

Air (Prevention and control of Pollution) Act, 1981 is an Act to provide for the prevention control and abatement of air pollution and for conferring powers to Pollution Control Boards for this purpose. It came into force in March 1981. Around mid 1981, there was a stipulation to ABC Cement Company by Pollution Control Board to limit the emission from stack within 250 mg/Nm^3. Further on publication of Air (Prevention and Control of Pollution) Rules, 1982 in the Gazette, in November 1982 a team from Pollution Control Board visited the Company. The Board issued a time bound program for controlling the dust emission from ABC Cement Company within the specified limits.

6.14 Higher Management: Objectives and Value

After reviewing the proposal (in Dec. 1982), the Vice President (Technical) - with 20 years experience in Cement Industry - enclosed a letter stating that they should adopt Electrostatic Precipitators (Fig. 6.5) manufactured by a reputed company. He further mentioned that although modified designs of Bag House Filters would be quite effective but the operation and maintenance cost were quite excessive. And that such adoption would be in accordance with the Company's policy 'of using the latest that technology could offer keeping in view the applicability, effectiveness and benefits which might accrue'. He agreed to the risk accompanying the adoption but suggested that the credibility of the equipment supplier and the number of earlier installations should also be explicitly taken into account before commenting on the risk involved. The proposal was passed to the Finance Department and Vice President (Operations) for specific funds allocation.

6.15 Worker's Reaction

The entire factory atmosphere was charged with discussion about the Company's decision of effective dust control. Somehow a rumor was spread around among the workers that due to low amount of dust pollution the dust allowance paid to the workers would be discontinued subsequent to implementation of the equipment. Number of inquiries were addressed to the management requesting clarification on the matter. The delay in management's response compelled the workers to run the second kiln erratically. Immediately the Personnel Manager held a formal meeting with a few influential group leaders (among the workers) and it was made

quite clear that the provision of dust allowance was a part of the Wages Act at National level and it couldn't be discontinued easily.

6.16 Implementation

The final equipment was installed and commissioned in 1983, almost eight months after the Pollution Control Board prescribed the limit. The performance and applicability was ascertained from the successful adoption and implementation of similar equipments in other cement plants. The managers feel that the active involvement of the equipment supplier has helped the adoption decision.

6.17 Present Status

The successful implementation (Efficiency of ESP reported is about 95 - 98%) has motivated the plant engineers to take up further work in the area of dust control. At present work is in progress at the clinker grinding section. Asked about the response of the workers the Factory Manager replied "Who does not like to work in a dust free and healthy environment!"

CHAPTER VII

CASE III : KOLBAKA CEMENT COMPANY *

7.1 Company History

The Kolbaka Cement Company started its commercial production of cement in 1960's using the wet Lepol process (details follow). The site of the project was selected in a notified backward area. Fifty two acres of land were purchased and adequate arrangements were made for the requirement of raw materials, transportation, power and water. The Company obtained a mining lease of over 208.9 hectares of land at a nearby village. Due to several constraints such as power cuts, non-availability of coal and few labor strikes the production had been erratic which in turn has caused a large variation in the sales and net profit figures.

7.2 Wet (Lepol) Process of Cement Manufacture

The wet (Lepol) process (Refer Fig. 7.1) employed in the manufacture of cement differs from the dry process (Case II : ABC Cement Company) only in the treatment of raw materials.

In the wet process the raw materials are crushed and stored without drying just as in dry process. They are then mixed in proper proportions and fed to the grinding machinery, at which point water is added and the materials are ground wet. The result is a thin mud or "slurry," as it is called, which is made just fluid enough to flow

---

All names (of company, person and places) have been disguised at the request of the person interviewed.

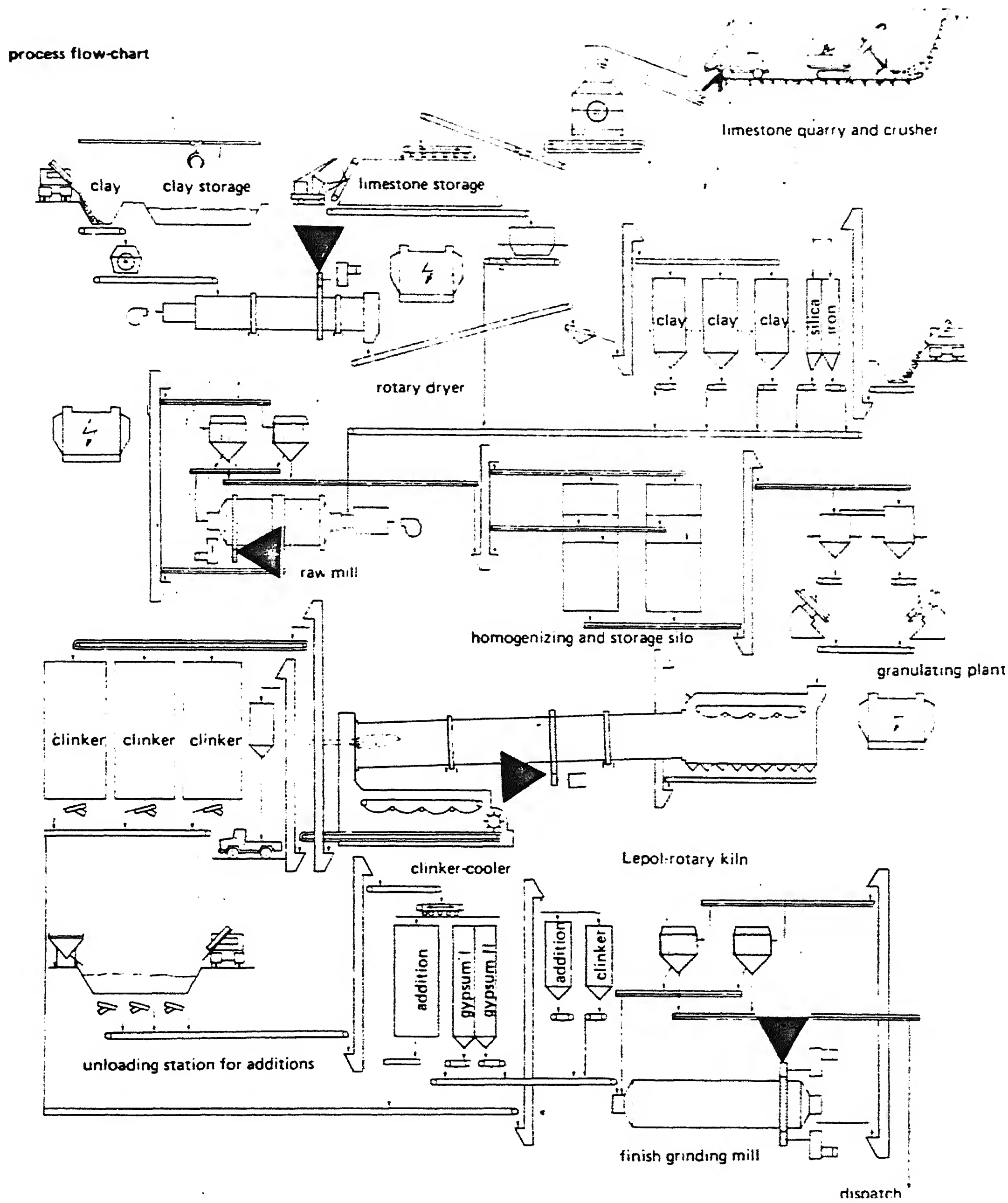


Fig. 7.1: <u>Wet (Lepol) Process.</u>

easily. This slurry, containing from 35 to 40 per cent water, is fed directly into the kiln and burned.

7.3 Nature of Pollutants

The largest air pollutants in Kolbaka Cement Company are the particulate emission and consists of carbonates, silicates, aluminates, fluorides and alkali halides,emitted through gases. The use of lower grade raw materials leads to generation of kiln dust richer in silicon dioxide and alkali halides. The ash from the coal adds further to silicon dioxide content of the dust from the kilns. The gases from the kilns (of the plant) are generally identified as carbon monoxide, carbon dioxide and nitrogen oxides. Oxides of sulphur are generally absent due to the low sulphur content of the coal used by the Company. Hydrocarbons and other organic entities in the exit gases are absent as coal is the main source of fuel in the Company. The use of lower grade limestone (quarried from the nearby mine) leads to relatively high quantities of particulate matter and the particles in this case are relatively finer (about 30 - 35% of particles are in the range of 0 - 20 microns).

7.4 Initial Installations

During the initial installation and commissioning stage of the plant very few dust arresters in the form of Fabric Bag Filters were provided because multicyclones were also provided. In India, for wet process, multi-cyclones were considered sufficient then. There was little pressure from the authorities and sophisticated dust collectors were not considered necessary for the wet process.

7.5 Expansion Program

In 1977, almost seventeen years after its first commercial production the management of the Company encouraged by the market conditions thought it would be appropriate to increase the capacity of the plant. They entered into collaboration with a reputed foreign company of West Germany. In order to remain in the forefront or technology the management decided to use the precalcination process. The selection of precalcination process rather than the wet process changed many aspects of the operational parameters, so far as air pollution control problems were concerned, with which the plant process engineers were not very familiar. The selection of the process was inevitable considering heat and fuel economy.

7.6 Changes in Parameters

The selection of the process, unfortunately, increased the difficulties for pollution control equipment selection. The new process changed almost all the parameters of the exit gases, temperature from the range 140-240 C to 330 - 410 C, the dew point from 65 C to about 40 C, the dust concentration from 10-40 gm/NM to about 120 gm/NM and particle size distribution from 75 - 85 percent below 5 microns to about 93 - 98 percent below 5 microns. All these resulted in posing a challenge for development of the pollution control equipment for the kiln.

7.7 Help From Collaborators

The foreign collaborators were approached for providing a suitable solution for dust control. They suggested the installation of Electrostatic Precipitators along with dust collectors with

poly-propylene bags. The Company's Process Manager pointed out that there had been a lot of problems with Electrostatic Precipitators of other companies in India (installed in Sixties and Seventies) due to an increase in the resistivity of the dust after multistage preheaters. During this period the Company possibly became a little skeptical about the possibility of using Electrostatic Precipitators with the kiln because the Maintenance Manager said that the recovered dust would have high percentage of silica, thus making it unfit for recycling. The cost of installation would be excessive and the Project Manager said, "We are not overflowing with money." The best alternative was to postpone the issue of sophisticated pollution control equipment.

7.8 Background Of Manager (Maintenance)

The Maintenance Manager of the factory Mr. Rangarajan was associated with the plant from the beginning. Though he joined as a Foreman with a diploma, his hard work and dedication enabled him to get a number of promotions in a short time period. But he is a man blessed with certainties and with an aversion to make major modifications in the plant. Technical development and modern management theory offered all kinds of devices for improving productivity; but the old man, Mr. Rangarajan, was too much of an autocrat, he would never wear anything new frangled or 'progressive' - particularly if the suggestion came from a newcomer.

7.9 New Recruitment

In 1976, Dr. Sunil Kapoor was recruited by the Managing Director to take care of the expansion program. Right from the beginning of his career, Dr. Kapoor (who reported to the Engineering Manager) was

associated with a few cement plants. Even during his Ph.D. Program he worked on cement plants. Soon after the recruitment he suggested some modifications in the old cement kiln (combustion section) which was resisted by the Maintenance Manager but finally was approved by the then Managing Director and the modification was carried out.

7.10 Interest Generation

Dr. Kapoor after going round the new cement kiln noted the absence of sophisticated dust control equipment. By that time (1979) installing ESP had become a standard practice for cement plant dust control. But he found that the Company atmosphere was not conducive for floating the issue of pollution control immediately. As Dr. Kapoor had been earlier associated with the installation of ESP in other plants, he was aware of the techniques of interest generation. He made it a ritual to put up as many successful adoption cases as possible on regular basis. Soon people started discussing the feasibility of adopting some equipment. The General Manager (Operations) was also quite interested in some sophisticated equipment adoption. At various conferences conducted by Cement Manufacturers Association, he found that such adoption led to enhancement of the prestige of the Company and other companies were deliberately quite keen on the issue.

7.10 Conflict of Ideas

Meanwhile Mr. Rangarajan was trying out various trial and errors on the old equipments to make them more effective. He still felt that the adoption of ESP on a large scale would be a extravagant expenditure on the part of the Company.During the first discussion about equipment adoption Mr. Rangarajan showed the results he achieved and assured to

make improvements if he was given the time and resources. Mr. Kapoor strongly criticized his attempts and added that such efforts were not necessary while technology provided an alternative.

Soon after, there were rumors that the Manager (Maintenance) may resign if ESP was approved. Mr. Rangarajan's work had always been appreciated and he was not only hard working but also quite dedicated to the Company and his loss might effect the performance of the Company.

7.12 General Manager's Recommendation

The General Manager (Operations), Mr. Goodbody, decided that if decisions about a suitable technique to tackle the problem could lead to such condition the best results could be achieved if a consultant is hired and asked to carry out the task independently. In order to seek the approval of the Managing Director about hiring a consultant, Mr. Goodbody thought it appropriate to put forth his explicit analysis of the situation prevailing. Relevant portion of a confidential letter (dated March 20, 1979) written to the Managing Director for this purpose is reported below :

> 'The first thing we have to recognize is that Mr. Rangarajan is not only our greatest problem but also our greatest asset. Some people hate him, some love him, most oscillate between love and hate: but none of them are unaware of him or fail to respect him. Any change we want to bring must be built around him to have his overt backing. I suggest that for the problem of finding a solution to the pollution control in the plant, a consultant be hired to work independently. Perhaps

suggestions from an outsider would be listened to with more respect...'

7.13 Implementation

The Managing Director was in communion with the idea of Mr. Goodbody and in accordance with a directive issued by him, in 1980, a reputed consultant Mr. Das Gupta from Calcutta was asked to survey the plant and suggest suitable technology for adoption by the Company. Within a year the final proposal was worked out independently by the consultant. ESPs were recommended for coal section, cement mills and the kiln and along with dust collectors in other sections. After a few round of discussions only with the Senior Management Staff the order for the equipments were placed from 1982 onwards and installation began in phases from 1984. The order for the last ESP was placed in Feb. 1986 which is likely to be commissioned in April, 1988 and with that the entire program would conclude.

CHAPTER VIII

STRATEGIC DECISION MAKING IN ADOPTION

In this chapter, the preceeding three cases have been analyzed along with the relevant portions from the detailed filled in questionnaire received. The analysis is in two parts. Whereas part I, essentially a macro level analysis, deals with the strategic response of the firms and identifies the major characteristics of the strategy, Part II deals with the process of organizational decision making and describes how each decision (during the adoption and/or implementation of pollution control equipment) is arrived at when a number of persons are involved in decision making on almost each and every issue which in fact forms a micro level analysis.

PART - I

STRATEGIC RESPONSE OF FIRMS

In this section, we focus our attention on the practical systematic management of the adoption by firms to discontinuous changes in the environment with special reference to environmental protection. Strategic management is a systematic approach to relate the firm to its environment in a way which will assure its continued success and make it secure from surprise.

8.I.1 Relevance of Strategic Management to Pollution Control

Since, mid 1970s a new kind of turbulence - pollution control - increasingly has made itself felt. Unlike the earlier changes, which

arose out of uncertainities in one's own traditional business, the new turbulence came from unaccustomed and unfamiliar sources; from public pressure and from stingent government regulations.

An increasing number of such changes posed major threats - closure of the firm's business or punishment of the company personnel (refer various Acts) or opportunities - recovery of vital substance from wastes - to the firms. Due to which the strategy to deal with pollution control has become an important issue in the strategic management of the firm.

Though it is often voiced that investment in pollution control equipment/process is largely due to the pressure of the government regulations, but in as much as, an important corporate objective of any firm is long term profit maximization, the decision to adopt pollution control equipment/process is largely governed by the cost/benefit analysis which may accrue from such adoption.

Based on our survey, personal interviews and response of various companies we have tried to explore issues relating to the response of various types of firms to such threats/opportunities, the resons for delay in response and the flow of strategic information. Further we have tried to analyse how issues are analysed and what decision options the firms face when such weak signals (of environmental protection) are received.

8.I.2 Aspiration Analysis

In a historical perspective the development of two points over the years should be noted. The first is that society is no longer content, as in the past, with the aspiration of economic growth, and now has

other aspirations which frequently conflict with growth. Secondly, while managers are shown to share the owners' aspirations for profits and appreciation of equity, the present study has shown that they frequently have other aspirations (e.g. pollution control/environmental protection, concern for employee, etc.) which can run contrary to the profit.

But any objective chosen by a firm are assigned priorities. The fulfilment of non-economic priorities like investment in pollution control, depends in the final analysis on the firm's solvency. In Twentieth Century Paperboard Company the deliberations about the installation of pollution control equipment during the project stage was strongly attacked by the Finance Manager due to financial constraint. Again when a formal proposal was moved in Oct. 1977, the manager who chaired the meeting thought that it was unnecessary to discuss the proposal as there were many more pressing problems which were threatening the survival of the company. The effluent treatment plant was established in 1981 almost 3 years after commercial production commenced. Thus whatever non-economic objectives are added to the list, unless the firm makes adequate profit, its survival will be imperilled and none of the other objectives can be served.

This centrality of the profit objective is clearly understood by management and frequently missed by outsiders. It is reasonable to suggest, therefore, that priorities vary as a function of the profit level of the firm. In ABC Cement Company although weak signals about ineffective control of dust was received soon after commercial production commenced but the proposal to adopt sophisticated dust control equipment gained momentum only in 1980 when the capacity

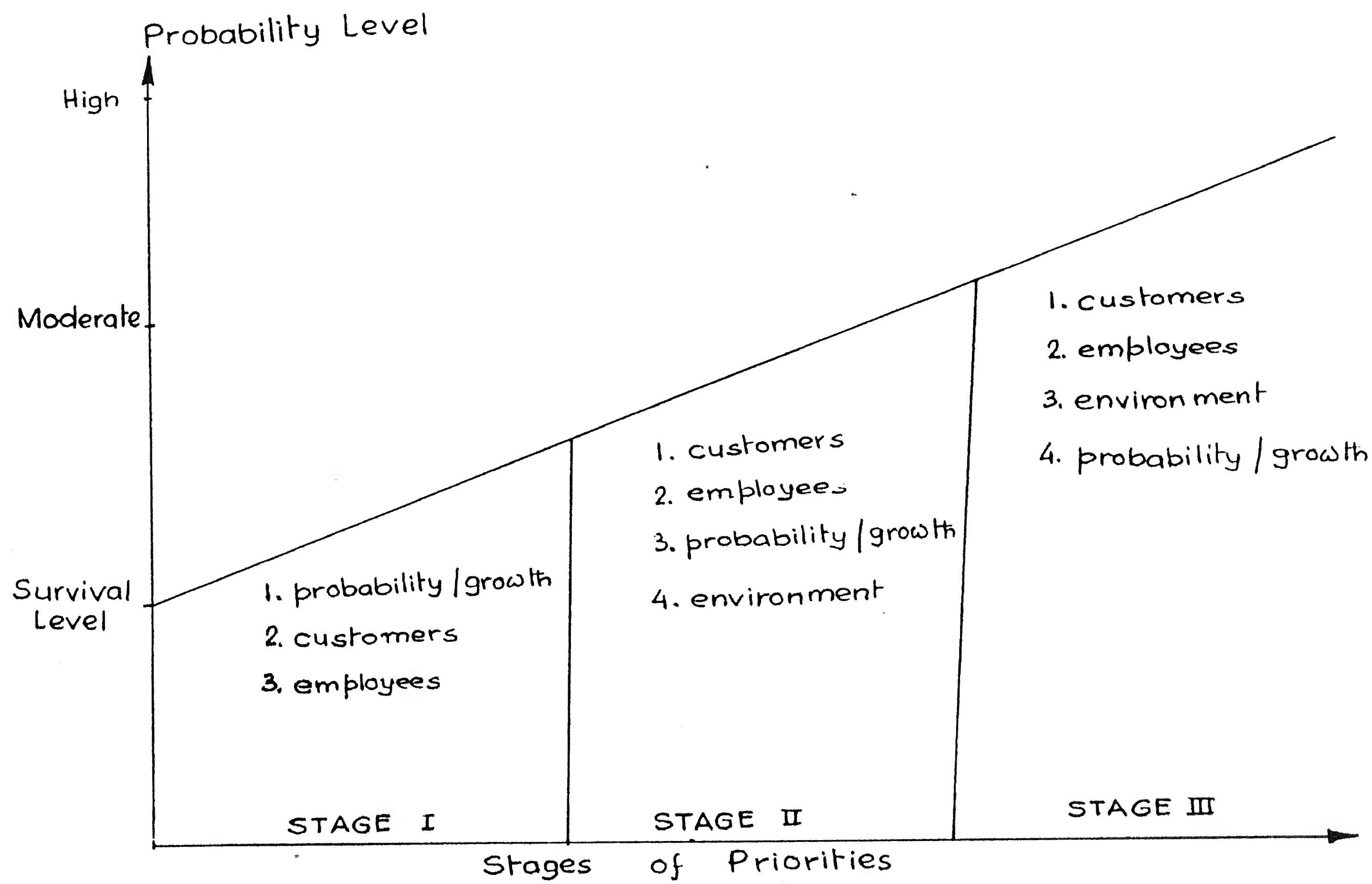


Fig.- 8.1: Priorities in a Societally Responsive Firm

utilisation increased to 75.33% from 41.62%. In Fig. 8.1 we have depicted the above facts graphically - how priorities usually change with the profitability level. Initially in Stage 1 when the company starts commercial production its survival is of paramount importance. Hence, maximum attention is paid to profitability/growth level. In the next stage when moderate profits are made by the company the priority on profitability/growth is less. Other factors like customers, employees may get priority and factors like concern for environment gets appended to the priority list. Only in stage 3 when the company starts making high profits and establishes a sound market (as in case of Company C4 refer Appendix to Chapter IX) the priority to environment is a bit more than to profitability/growth.

8.I.3 Delays in Response of Firms

The delay in the responsiveness of a firm can be traced to the organizational characteristics. From the cases described two distinct types of responsiveness of the firms emerge.

Firms like Twentieth Century Paperboard Company (TCPC) - typically small and led by young aggresive management - do not engage in much of environmental surveillance as far as pollution control or environmental protection is concerned. But they are quick to learn from the failure of conventional response and from the result achieved by others adoption. In TCPC this function is mainly performed by environmental and energy conservation department and periodic proposals about prospective adoption are moved. As soon as the data shows that profit figures can be increased by adoption of new equipment/technology, the management triggers a response. Hence the recovery process in TCPC was readily accepted while the treatment process was adopted only when the

management was convinced that it would greatly improve the companies image.

In other cases, as in Kolbaka Cement Company (KCC) - primarily a large and old firm which enjoyed a long history of success - the mere presence of persuasive data frequently fails to trigger a prompt response. Such firms almost refuse to recognize the impact of a novel equipment/process or of major political regulations. The trial and error process of achieving effective dust control was carried out in KBC even when relevant Acts were formed and Electrostatic Precipator were gaining wide spread acceptance. Analysis of case III in detail reveals a few contributing factors:

i) A delay which is due, in part, to the time consumed in observing, interpreting, collating and transmitting information to responsible managers. In another part, it is due to the time consumed by these managers in communicating with one-another and establishing a common understanding, as well as the time necessary for processing the decisions among the responsible groups and decision levels.

ii) Another type of delay may be invoked, because some managers will argue that even though the level of impact has reached unacceptable proportions, there is never an iron-clad assurance that the threat is real. They will opt for "waiting a little longer" to see if the threat will "blow itself out".

iii) Another delay may occur if certain managers, whose domain contributes to the crisis, feel that recognition of a crisis will reflect on their reputation and/or will cause them to lose power. Even if they are convinced that the threat is real, they will

want to fight a delaying action, to gain a breathing space to develop a line of defence or to line up a line of retreat.

iv) Another delay would contribute to the other three if the managers are trained to trust prior and familiar experiences and reject unfamiliar ones as improbable and invalid.

8.I.4 Response Pattern of Different Types of Firms

The period between the first awareness about tackling pollution control and the point in time at which management turns to coping with it may last months or even years. But it would be wrong to visualize the pre-trigger period as one of watchful inactivity. During this period deficiencies in the major information sources and various signals are perceived, analyzed and corrected.

The analysis of the three cases described, throws light on the differences in the response patterns of the three firms which are briefly discussed below.

The Kolbaka Cement Company (Case III) was producing cement using the Wet (Lepol) Process for 17 years. Neither any new equipment was installed nor modifications were made in the process. The employees and junior managers were familiar with various operating measures implemented from time to time and they were acceptable either because they had been tried before or because their impact could be forecast with confidence. For such firms, which had historically confined itself to incremental strategic changes, drastic measures like adopting an equipment employing a totally new concept of dust particle separation, appear strange and risky.

After 17 years a drastic strategic measure of increasing the

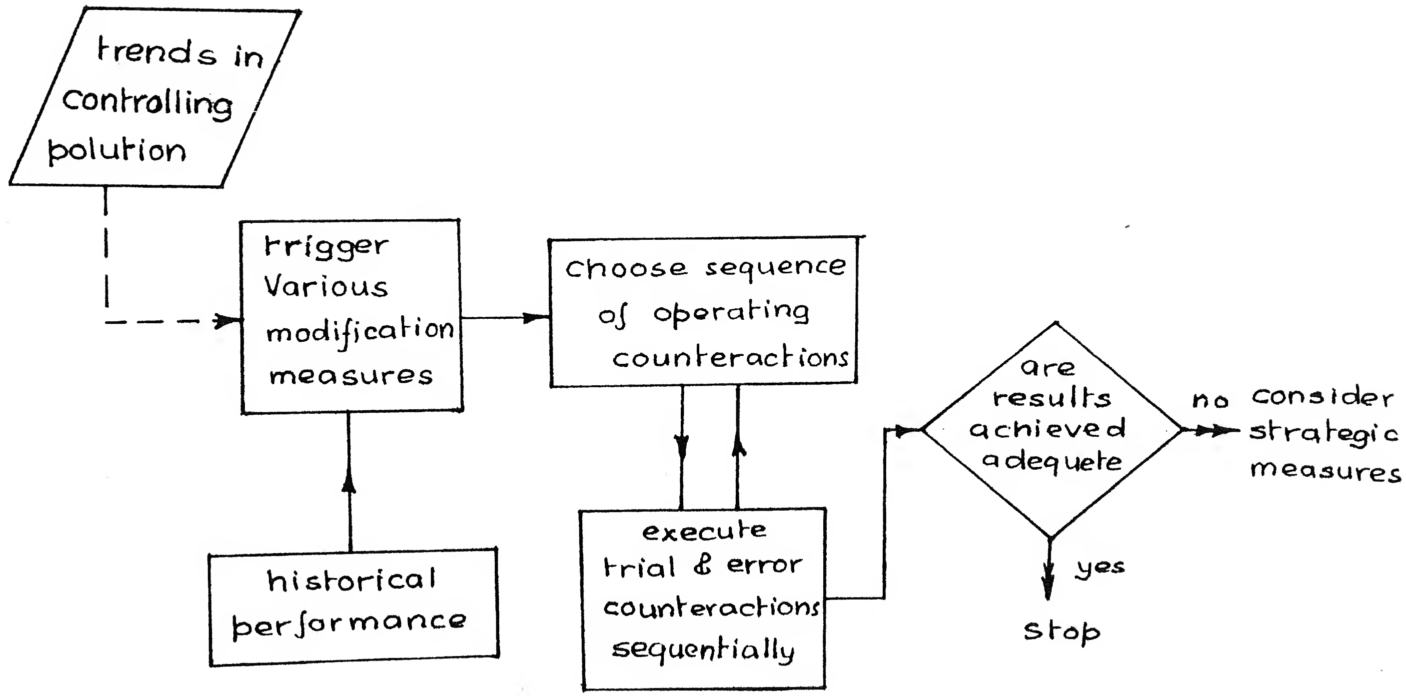


Fig.- 8.2: Sequential Response to Dust Control in Case III

installed capacity was executed. When equipment had to be designed for reducing the dust emission both for the old and the new plant, the initial assumption was that the difficulty can be overcome through familiar operating counter measures with modifications. Accordingly a series of measures were tried sequentially starting with ones which have been successful in the past or with minor modifications thereof.

For such firm's if none of the counter measures - mostly of trial and error type - produces a sufficient improvement, the tendency is to conclude that, for the moment, the situation is out of the firm's control, but that the disturbance is temporary and that if the firm holds out long (with enough resources made available to carry out experimentation) the situation will blow itself out. Only when the situation losses continues (due to investment in experimentation) or results achieved are not satisfactory,does the firm with a Senior Manager's timely intervention, turn to a strategic measure of adopting or implementing a new concept. Meanwhile, a great deal of time has been lost, and the situation worsened. Fig. 8.2 is a representation of Case III type of firms.

In case I (TCPC) the initial response of the Twentieth Century Paperboard Company to ordinary operating measures is similar to that described above. The firm is still undisposed and unprepared to face the unfamiliar threat. But instead of sequencing a trial and error counter measures the firm analyzes, selects and executes the best appearing combination of counteractions. Had these proved futile, the company would have moved decisively to strategic counter measures. The success of the twentieth Century Paperboard Company can be attributed to two factors - i) presence of a specialized section to deal with the

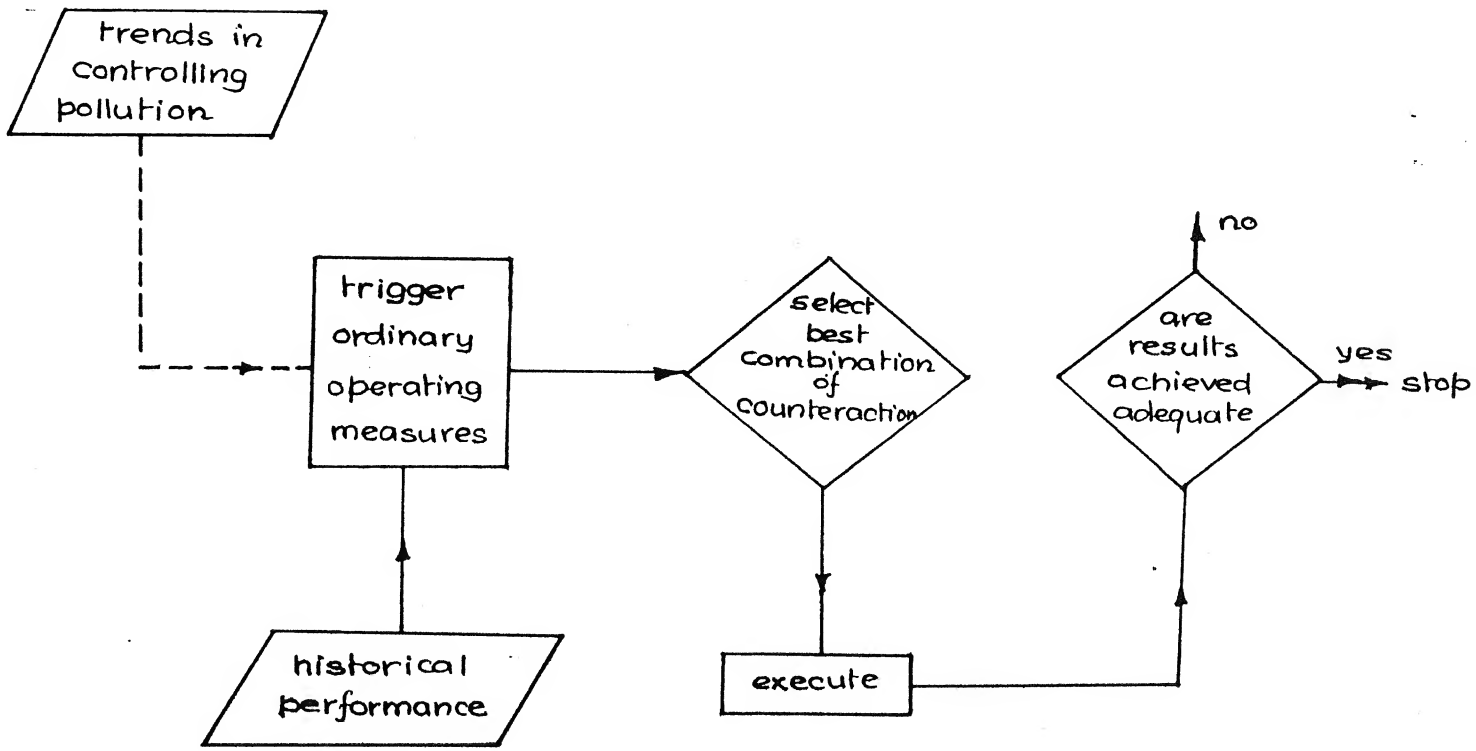


Fig.- 8.3 : Sequential Response in Case I

problem and ii) the capability of the senior management to carefully deliberate on the issue. Fig. 8.3 is a representation of Case I type of firms.

Both types of behaviours described are after the fact: the response is triggered after tangible losses has been inflicted on the firm. Such behaviour is not surprising in firms which rely on historical sources for information. Twentieth Century Paperboard Company is a relatively new company hence it could not rely totally on historical information and remained relatively more watchful for better methods.

The response of ABC Cement Company (Case II) is markedly different from the two cases described above because of existence of a purposive ring of strategic planning which is explicitly stated much in advance. The Vice President (Technical) of ABC Cement Company raised the issue of effective dust control in the annual performance review meeting, as early as 1980, which is an indication of environmental surveillance.

Basically the strategy formulated in ABC Cement Company was for guidance of the organisation - guidance as to how the company would cope up with pollution control. Usually the process of strategy formulation results in no immediate action, it sets the general direction in which the firms attention should be directed, which is next used to generate strategic projects through a search process. But in case of ABC Cement Company the search process was almost simultaneously focussed (information acquisition phase commenced a few months before annual peformance review meeting) on the relevant area. Various information sources were explored, ways of disposing the installed equipment along with the large amount of resulting inventories, write-off of asset, etc.

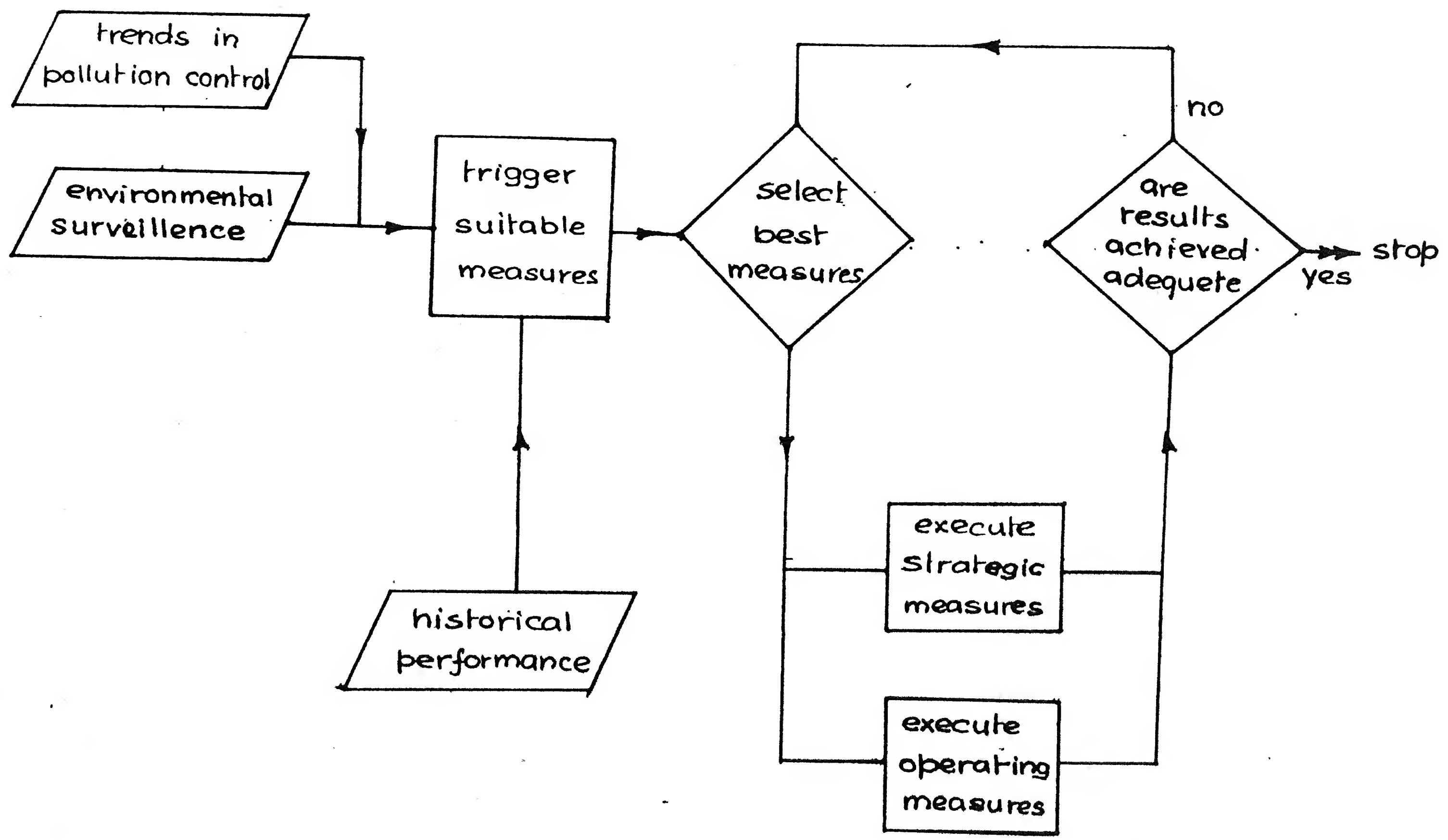


Fig.- 8.4: Response in Case II

were thought. These, which we shall refer as, "operating measures" were simultaneously in progress. Suitable discussions were triggered which reviewed not only the historical performance of the equipment but also the trend in pollution control in the cement industry of the Country. The best alternative was selected and the strategic and operating measures were thus executed. The results achieved was satisfactory otherwise the last cycle would be repeated. The major difference is because the strategic and operating measures are considered simultaneously. Such response can be attributed to the historical dynamics of the organization characterized by a timely focus on the preferred area. Fig. 8.4 is a diagrammatic representation of such a response.

8.I.5 Comparison of Behaviours

The key difference in the three cases arise from the manner in which managerial decisions are sequenced.

In Case I (Twentieth Century Paperboard Company),initially ordinary operating measures are triggered, but, when it comes to specific measures, an analytical approach is used: alternatives are identified, compared and then implemented.

In Case II (ABC Cement Company), both the type of response and the measures are chosen through comparisons and analysis of a number of parallel programs.

In Case III (Kolbaka Cement Company), strategic response does not commence until after the operating options have been exhausted. The specific measures are tried sequentially, one at a time. The behaviour is an experienced - dependent trial and error process.

TABLE 8.1: Comparison of Behaviour in the Three Cases

	Case II	Case I	Case III
Initial Phase	acts in advance of threat	Acts when rational threshold is reached	Delays trigger past threshold until sure of threat
Trigger Phase	- assumes threat as operating - select both optimal strategic and operating response - executes the best measure	- assumes threat as operating - select best combination of counteractions - turn to strategic response	- assumes threat as operating - responds sequentially - try past operational success - turn to strategic response
Structural Features of Organization			
Ownership Structure	- a unit of the largest business house in India	- promoted by a multinational	- a small group
Existence of Technical Specialists	- absent	- present	- present
Inter-Organizational Communication	- high	- moderate	- low
Planning Method	- long term (3-4 yrs.) and annual plans - flexible	- long term (2-3 yrs.) and annual plans - highly flexible	- only annual plans - not so flexible

Table 8.1 brings together the three types which may be distinguished from one another on a number of characteristics - important among them are the sequence in which specific measures are taken to combat the problem of pollution control and the historical performance variables. In the initial phase where as ABC Cement Company deliberates on the issue of pollution control much before a critical stage is reached which is due to environmental surveillance by the Company's management, Twentieth Century Paperboard Company acts just in time which enables them to bag an award. But Kolbaka Cement Company delays trigger of response to Electrostatic Precipator until quite sure of the threat posed. In describing this the term 'threshold' is used in the Table. Rest of the terms used are self explanatory.

8.I.6 What Can a Firm Do?

When a firm encounters the issue of pollution control, three costs are incurred. The "cost" of goodwill of the public and pollution control authorities, the loss caused by non-recovery of material and the cost of arresting pollution. The managements task is to minimize the three losses. However, if the firm waits until the impact and consequences of investing in pollution control can be accurately estimated, it might be too late to launch a timely response. In such cases, it would be best to start response while the information is still partial. The advantage of taking early action is that it permits the firm to make responses which would be missed, if the firm were to wait. In addition to starting early, the firm can improve its timeliness by using special task force.

The choice of whether and how to respond should be determined,

first, by comparing the timeing of the response and, second, by comparing the gain to the firm responding to the cost of making the response.

About the differences in response patterns, it can only be said that all the patterns described have their place in the repertoire of management response to pollution control. However, in slowly changing environment, Case III, while costly, can avert disaster. But, as the pressure becomes more and more pressing, it would be useful to use Case I or preferably Case II (which has an element of forecasting and planning) type of response if the firm intends to avoid the negative consequence of the impact.

PART II

DECISION MAKING IN ADOPTION

In this section, as pointed out earlier, the decision making process in general and pollution control equipment/process adoption decision making in particular is analysed. Attention is particularly focussed at who are involved in decision making in organisations, what they get and how they go about getting it.

8.II.1 The Decision Making Unit and Discretion

Decision-making in organisations is frequently shared between a number of people or 'actors', their coalition. Who are the members of the relevant coalition very depending upon the decision and does change over time. The initial proposal was prepared by Mr. Paul (Twentieth Century Paperboard Company) but the second revised proposal was prepared jointly by Mr. Paul and Mr. Brown which was necessarily technical in

nature. For evaluating the managerial aspects of the proposal, the group consisted of senior managers of the company although the proposal makers were present to clarify the doubts. The decision making regarding pollution control equipment adoption is 'decentralised' between a number of participants (usually the participants are Process Manager, Maintainence Manager, Manager Design and Development or research and Development, Manager Finance but very rarely Manager Marketing or Manager Quality Control participate) in most of the companies. Discretion is an important concept in understanding how decisions occur in organisations. It means that although people are directed they still have a wide choice of action.

8.II.2 Conflicts and Negotiations

When what occurs depends upon the views of several people, then what happens is the result of conflicts and negotiations between them. In Case I decision were arrived at by negotiation between Mr. Paul and the management who shared a vague goal (of protecting the environment from pollution) but disagreed on the means to achieve it. Organisations if they do have stated operationaisable goals, the goals are several and conflicting (for e.g. productivity and quality). Actors take positions on issues according to their own interpretations of the organisational goals, their own personal goals and their position or roles in an organisation. "Different responsibilities laid on different shoulders, as well as differences in personalities encourage differences in perception and priorities", according to the Factory Manager in Case II (ABC Cement Company).

8.II.3 Power

Men share power; men differ concerning what must be done; they attempt to persuade those whose agreement is needed to see the problem from their point of view [1]. The adoption of ESP by Kolbaka Cement Company was mainly due to the persuation of Dr. Kapoor. Differences are resolved by negotiation and bargaining between various company personnels who have different positions in the hierarchy of the organisqtion, who thus see the issue from different angles and have different abilities and power. In Case II detailed discussion about the distinct advantages and disadvantages of various methods of controlling dust by the Process Manager, the Maintenance Manager, the Industrial Engineer and the Plant Engineer were so diverse that initially the discussion remained inconclusive. An actor's position or role in an organisation assures some standing in the game and defines what he may and must do. Mr. Paul (in Case I) who was recruited mainly to head the pollution control and energy conservation section pushed the proposal of waste effluent treatment. An actor's power, the ability to influence policy outcomes, determines what he achieves. Power is like a resource, wisely invested it yields an enhanced reputation of effectiveness, but applied foolishly and unsuccessfully will reduce future effectiveness. The Managing Director of Twentieth Century Paperboard Company turned down the proposal initially without giving any explicit reason but six months later he accepted the same proposal with lot of concern and enthusiasm. Today the company personnel are happy about his timing of the decision which enabled them to receive the 1983 award for establishment of excellent effluent treatment plant.

Thus organizational decision are the result of bargaining between many individuals who have power, who only vaguely share the same objective, and who do not necessarily agree on the ways to achieve that objective and can also exercise discretion. These individuals differ in their responsibilities and consequently their importance of the importance of the many issues competing for a manager's attention. Each individual also differs in his power to influence outcomes, due to his position in the organisation, his abilities and his reputation.

8.II.4 Emergence of Choice

Quite often a decision does not make sense unless quite distant events and factors are taken into account (Case III). Rather decision making can be described as the emergence of choice from a continuous social process of mutual influence carried on between a large number of people who operate within a social system, restricted in their freedom of operation by the organisation's strategies and accepted codes of conduct. In spite of availability of an experienced technical man (in Kolbaka Cement Company) a consultant was hired to provide solution to the dust problem, mainly to maintain the harmony among the various departmental heads.

8.II.5 Social Values and Culture

'The social system', the values of the community or culture within which individuals operate also influences and restricts a decision-maker. The precedents of what the organization has done before and the way it does it, determines to a large extent the permissible area of development and appropriate solutions and method of evaluation. In Case I the Twentieth Century Paperboard Company enjoyed an excellent

social image. It wanted to maintain its image even in the field of environmental protection by adopting pollution control equipment without unnecessary fuss. there are also codes of behaviour which determine how alternatives are evaluated. For instance, the Chief Chemist of a reputed fertilizer company, blurred out saying, "We are here in business to make money and not to protect the environment - a wastage of money."

8.II.6 Company Policy

It is evident from the cases that the active leader is restricted in his activities by policies and decision rules - that they are prescribed to him by the system in which he works, acts and lives. The final choice by ABC Cement Company was affected by the company's policy of utilizing the latest solution that technology could provide. In Case III more importance was given to fostering a better relationship between department heads and hence a consultant was hired.

8.II.7 Inter-Personal Harmony

In Decision Making Process individuals do not operate alone and they realise they will have to continue to work with their colleagues, actors consider the effects of a decision on their colleagues and their colleagues' wishes and ambitions. In Case III although Dr. Kapoor was quite capable to handle the problem, he was not allowed to because of the fear of distubing the "harmony" among the department heads. In Case I, the management requested Mr. Paul to prepare the proposal although Mr. Brown had proved his competence on earlier occasions. They realise that they will have to continue to work with each other and this set of negotiations is just one in a series and how each side comes out of this negotiation will affect future negotiations. "Consciously and/or

unconsciously individuals weigh their relationships in making their decisions." These interpersonal relations produce a continuous process of mutual influence which affect an individual's reation.

8.II.8 Prior Influence on the Decision Maker

A decision maker's urge to invest in pollution control equipment can also be explained in terms of some kind of prior and group influence: his education (for example, the Ph.D. as in case of Dr. Kapoor in Case III), his past experience (the Vice President's experience in Case II, helped him to choose from among the alternatives suggested), the written oral communications he received both in and outside the firm (for insance Mr. Paul in Case I), his reference group - all influence this urge.

8.II.9 Self Interest

A decision maker is also guided by self-interest. What is self-interest in a particular case, depends on both the individual's value (for example Mr. Rangarajan in Case III) and personality but also upon other individuals around him, the conventions of the organization, its circumstances and problems, etc. To say that individuals operate self-interestedly is not intended to be cynical, it is difficult to see - as illustrated by the case studies - how an individual could operate otherwise.

Mumford and Pettigrew [1] came to a similar conclusion in their study of companies choosing and adopting computers, "that decision-making process can only be understood if it takes account of the personal values and interests of the individuals and groups concerned."

8.II.10 Time - A Scarce Resource

Time is the scarce resource, so an administrator allocates his time to maximize his self-interest. Managers are often very busy, so issues have to be brought to their attention. "The problem is not so much that we do not have enough information, we have too much", according to the General Manager of Orient Cement and individuals are forced to select. Each one of the participants defines his role in the system and chooses the activities to which to devote his time and the issues on which he focusses his attention according to the salience he attributes to an issue. In many cases (especially in Case I) the cost of management time is so great that small projects (which at times also includes pollution control equipment adoption) are not worth considering.

8.II.11 Decision Initiating Force

Decisions, in an organization usually do not start with the definition of a given problem, they start with an initiating force, although they are difficult to precisely pin down, which can come either from within or outside the organization. An initiating force from within the organization can come from a drive launched by a high ranking official. From outside the organization proposal can come from a company distributor (pollution control equipment manufacturer/supplier), a representative of Government, from the fear of losing the company's image, from the fear of entering into the fuss of legislation or from a "bandwagon effect" because other companies are investing for protecting the environment. However, it was quite evident from the survey that an investment needs the support of senior members of the organiation if it

is to succeed; a pollution control project can only be sold if it has some appeal to an executive who conceives it as serving some need (for example, the commitment of the Project Manager in Case I).

8.II.12 Investigator(s) and Investigation

The initiating force generally stimulates an investigation of a project. Investigators attempt to avoid conflicts with the interests of other executives or with organisational practice as in Case III. Information about alternatives (of combating pollution) and their consequences are far from perfect, there is a large amount of uncertainity and it takes time and effort to digest the information. The Finance Manager(s) believe that there is no objective way of allocating resources for pollution control and the expenditure process is more of an art than a science. The variables chosen to be investigated, the depth and scope of the investigation and the evaluation of the various ingredients encountered all depends to a large extent upon the nature, basis and magnitude of the initiating force (which is maximum with the intervention of Pollution Control Board) and the perception of the investigator as to the type of problem posed by the force. When a time bound program is issued by the Pollution Control Board the various investigations conclude in a very short span.

8.II.13 Limited Decision Maker's Freedom

The final decision to invest in pollution control, many a times, is the result of an accumulation of small day to day acts which create unintended consequences, become precedents and limit the decision-maker's freedom. From this point of view decision making might be an unhappy term, commitment may be more

descriptive of the process. The accumulation of small acts produces commitment among the group of critical personalities which eventually produces the decision to adopt. The investigators usually anticipate their superior's reactions and align their proposals with the desires of their superiors and as the top management is conceived, possibly erroneously, as unwilling to take too much risk, analysts choose solutions and methods of analysis and presentation to satisfy top management's perceived values and worries. From the analysis of the response to questions 20 and 26 (Part - C) of the mailed questionnaire (enclosed in Appendix) we find that the potential benefits, burdens, applicability and the results of earlier such adoptions are stressed in the proposal(s) which help to reduce the risk of adoption. In Case I Mr. Paul had an informal discussion with the Project Manager before submitting his proposal and re-oriented it accordingly.

8.II.14 Part II in Brief

We can thus see that there are many factors involved in organizational decision-making. Decisions are the outcomes of a process of negotiations and influence between a large number of people who are directly and indirectly involved, each of whom are influenced by the roles they occupy in the organization, their education, experience and all other personality traits that can influence a person. Individuals are restricted by the physical and financial capacity of the organisation, by the organization's accepted forms of behaviour and its culture. Individuals working within these constraints, with incomplete and inaccurate information, have many issues being brought more or less

to their attention, they choose issues on which to use their limited time according to their perception of the points of importance or leverage which gives each the greatest satisfaction.

Therefore, in order to understand a decision making process it is not enough to analyze the technological forces alone. The decision process in adoption also involves corporate strategy, individual orientation, community as well as group norms and values. In brief, a very complex process.

CHAPTER IX

FACTORS CONSIDERED IMPORTANT FOR ADOPTION

Although the insight gained about the process of organizational decision making and strategic response of firms in adoption of pollution control equipment, from the survey and detailed analysis of cases are presented in the previous Chapter respectively, a few important and general aggregated observations are worth considering in this section.

The inquiry was based on personal interviews and response to mailed questionnaire concerning the decision making process in the adoption of pollution control equipment in three industries - Pulp and Paper, Cement and Fertilizer. The questions concerned the enterprise and its organization, the equipment (the technology) and those detailed aspects of the adoption decision process which were believed to influence its flow within the company, such as its importance, the origin of the impulse to get involved in it, the search for solutions, the method of decision making, etc., The empirical material is presented in the Appendix to this Chapter.

9.1 Role of Top Management Support

For the sample of 13 firms (3 in Pulp & Paper Industry, 5 in Cement Industry and 5 in Fertilizer Industry), the single best factor responsible for quicker adoption of pollution control equipment was the keen interest and support of the top management. The other important factor is the impulse created by the belief that such adoption would lead to increase in the status of the company in its reference group.

Availability of finance, technical manpower and ease of understanding the equipment were other factors influencing the adoption of pollution control equipment. Individuals seem to stimulate the adoption process most when a recent manpower flow is involved; that is crossing of an organizational boundary by a key organizational member coming to the organization or department of the adopting firm. Government regulation tends to produce the expected result - stimulation shortens the time period to make adoption decision. In particular, a key moderating variable is the significance or relative importance of an equipment to the firm. Perhaps the reason that relative advantage increases the adoption time is that more conservative organizations require higher relative advantage for adoption. One way to ensure higher relative advantage is to adopt equipment with a proven track record.

9.2 Union Reaction

Union reaction to the pollution control (response to Question number 10 Part - A) equipment being considered for adoption, has much impact on the final decision. The union in most of the companies either encourage or accept such adoption decisions because it leads to a better working environment and also it counteracts the threat of polluting the locality in the vicinity of the plant, which forms the workers abode.

9.3 Sources of Development

The result of the response to questions 17 (Part - A) and 27, 28 (Part B) indicate that for this sample the largest source of development was outside. The second most important development source was collaborative and the least important source of equipment development

was in-house. This is because heavy reliance in foreign technology dominates the pollution control equipment scenario. Consultants were involved in the development of a pollution control equipment in two cases.

9.4 Stimulus for Adoption

For each pollution control equipment adoption, data were obtained on stimulus or precipitating events which acted during the decision-making process (Question 4, Part A). The overall findings for this study indicate that recovery of valuable substance was the primary stimulus for adoption. To a lesser extent Government rules and regulations stimulated adoption. Least important was the stimulus category of response to environmental protection or social concern which lead to initiation or stimulation of pollution control equipment adoption in 2 cases. The most persuasive effect came from the new management personnel assuming positions in the respective firms. This result suggests the importance of manpower flows in the adoption process in this study and that this variable merits further investigation.

9.5 Propelling and Blocking Factors

Based on the response of the various companies to Question No. 12 in Part C of the questionnaire, we find that the main factors that propelled the company to adopt the pollution control equipment/process are:

1. Location of the factory,
2. Government policy on environment and
3. Profitability of investing in pollution control.

The factors that tend to block the adoption decision are:

1. High installation cost,
2. Lack of reliable equipment and
3. Lack of maintenance support.

9.6 Role of Government Intervention and Action

This sub-section is based on the response of the firms to questions 9 (Part A), 29 (Part C) and 30 (Part C) of the questionnaire (enclosed in Appendix - D). Government rules and regulations play an important role not only in the business of an enterprise but also in pollution control equipment adoption. Under its absence the firms behavior has a tendency to be based on the theory of Adam Smith, which states that the public is best served when the pursuit of profit is conducted under minimum possible constraints from society - a condition known as "free enterprise". Also, government action has a pervasive influence on the adoption process, which is due to the influence of government actions on various aspects of the adoption process: for example, the type of equipment that are considered (based on the limit of noxious substance prescribed by the Board) and the agenda for decision making, etc.

Almost all the firms covered in this survey had a favorable attitude towards government policies and Pollution Control Board. The close co-operation between the two can be judged from the following examples (i) During the annual shut down of the plant, the Board permits the direct discharge of the pollutants without any treatment and (ii) when a firm is going through a tough phase or turmoil, the Government/Board does co-operate with the firm by being not very strict

in the immediate adoption of pollution control equipment or immediate implementation or the time bound program.

However to further improve the situation prevailing, the Government could intervene in following ways:

a) Effort should be made to bring together the personnel of different firms in one industry so that all the technical details, the prospects and drawbacks of various strategy of pollution control relevant to that industry can be discussed. Such effort would be of great significance for providing better information and better problem solving,apart from enhancing the "prestige" factor in adoption.

b) Methods should be developed for the joint treatment of effluents from various industries (concentrated in a particular area) by mutual co-operation. This would not only go a long way in achieving better protection of the environment but would be very cost effective.

Without attaching priorities, other measures which deserve consideration include the following: an effective advisory and service for technological problems related to pollution control; a documentation system, a record of results achieved by various industries after adopting pollution control equipment; facilities for further education and training in relevant technology. Many measures - some of them already in force - can be proposed to assist companies in their adoption (of pollution control equipment) decision. The importance of a well organized information and monitoring service is supported by our findings (response to question 22 & 23 in Part - C) that the specific

knowledge considered necessary to solve the problems encountered were not available at the outset of the decision making process in at least half of the cases studied.

9.7 Inter Firm and Inter Industry Differences

Based on the response of the various companies to Part A, Part B and Part C of the questionnaire (refer Appendix) the various factors influencing the adoption of pollution control equipment have been analyzed in this section. No undue generality is implied in the analysis. The response of thirteen companies merely provide some insight which may be subjected to further scrutiny. These insights are based on

a) scaled data (see Appendix to this chapter) and

b) qualitative information about the companies.

9.7.1 Speed of Adoption

The various factors (see Appendix to this chapter) were analyzed in the context of speed of adoption. For comparing the adoption speed the differences between, on one hand, the date of the relevant pollution control Acts or the date of commercial production, whichever was later and, on the other, the date of ordering the equipment was taken as an index. In case the company was established after relevant statutes were constituted a continuous pressure to adopt pollution control equipment would exist right from the date of commercial production. On the other hand if the company had been in commercial production much before the relevant Act(s) were framed the pressure would start operating from the date the Act(s) comes into force.

9.7.2 Adoption Propensity, Attitudes and Values

Three organizational variables were evaluated for an organization - its adoption propensity, attitude towards industry and social values. The disaggregated nature of data of the sample (presented in Appendix to this chapter) make it extremely difficult to identify the relevant organizational factors (out of above three). Perhaps, larger sample could throw more light on the issue.

9.7.3 Why Industry-Wise Analysis?

Our analysis so far shows wide variations in process of adoption. Sources of some of this variation can be controlled by comparing firms within the same industry. Therefore, the ensuing analysis looks at cement, pulp and paper and fertilizer industries separately.

9.7.4 Pulp and Paper Industry

Features relevant to this industry are abstracted in table 1. A cursory glance at Table I shows that the company P2 was the first to adopt pollution control equipment in March, 1978 followed by company P3 and P1. All the three companies adopted similar method of effluent treatment - Activated Sludge Process - which was the first process to be adopted to combat pollution control.

Faster adoption in this industry seems to be aided by the following factors:

a) Government regulations - Provision for proper effluent treatment (upto the limits specified in relevant Acts) was a prerequisite to get the certificate for commercial production for company P2. But legislative pressure were not prevalent when company P1 started business in 1965 and Government pressure acted much later on

company P3 (in 1980s) which delayed the adoption.

b) Availability of Finance - Acute shortage of finance due to cost over run in the project stops (in company P3) and due to investment in quality improvement of the finished product (in company P1) delayed the adoption. Lack of financial constraint hastened the pollution control equipment adoption in company P2.

c) Presence of a R & D Department - The technical personnel (Environmental Engineer(s)) working in the R & D department of the company P3 pushed the proposal of pollution control equipment. The absence of such a specialized department in company P1 delayed the adoption.

d) Proximity of Densely Populated Area - Densely populated cities or towns were not there near companies P1 and P3 and hence pressure from the nearby community was absent.

e) Agreement With the Collaborators - A 5-year contract was signed by the management of company P2 with their foreign principals during which period every kind of assistance was assured. Hence the management was keen on establishment of a complete plant (along with effluent treatment plant) so that after expiry of the contract period no further modification, by way of new equipment adoption, would be necessary. Close contact with the collaborators also enabled the company personnel to have an access to latest information sources.

f) Equipment Attribute - Whereas company P2 perceived the process to be easy to understand and use, the other companies differed. The nature of the equipment did not permit experimentation on a limited basis. The adoption by company P2 was also propelled by the fact

TABLE 9.1

Company	TECHNO-ECONOMIC FACTORS *		EQUIPMENT ATTRIBUTE *		Aid to Company's Image	DATE OF	ADOPTION TIME LAG (in month:
	Information Sources	Finance Availability	Comple-xity	Compati-bility		Order-ing	
P1	4	4	3	4	5	Apr. 1981	85
P2	1	1	1	1	1	Mar. 1978	48
P3	2	3	3	4	1	Jan. 1981	83

* 1: Strongly yes, 2: Strongly no.

that it could easily adjust to the process.

g) Company Image - The company (P2) management's perception that such adoption would greatly improve the image of the company accelerated the adoption process.

9.7.5 Cement Industry

a) Recovery Value

The adoption process of pollution control equipment in the Cement Industry has a marked difference as compared to that of Pulp and Paper Industry. The ASP was adopted by the Pulp and Paper Industry where there was virtually no treatment given to the discharged effluent as far as environmental protection was concerned. But almost all the cement plants had installed some kind of dust control equipment mainly because the recovery value of the material, in a cement mill, is considered to be of much more importance, at least in our country, than the control of air pollution. Of course, the emission being 2 to 5 % higher in dry process, the plants with wet process have a somewhat lower pressure to adopt.

b) Displacement Decision

Except company C1 (which is not in commercial production yet), the adoption decision in other companies was mainly a replacement decision - ESP displacing the original Bag Filters. Being a replacement decision much more serious obstacles were faced. Apart from production cost criteria such displacement would then involve writing off any remaining undepreciated investment in existing dust control facilities - an especially unattractive prospect. Moreover, prospective displacement also tended to be confronted by high (often excessive) estimates of the change-over costs involved in effecting attendant adjustment in

employment levels, job descriptions and skill requirements and associated supervisory arrangements - in contrast to the relatively simpler process of dust control adopted earlier.

c) Environmental Factors

Under such conditions the displacement was effected by various environmental factors - increasing statutory requirement of dust control (not attainable via older facilities) by Pollution Control Board being an important propelling force. Also the cement industry noted the development of ESP in the country and their virtual maintenance free operation. The apprehension about the applicability of the equipment was however, removed when a number of installations were successfully made in this Country. Even then the adopters were not left with much choice because of the almost monopolistic nature of the supplier market.

d) Other Factors

The following factors also had a major impact on the adoption decision (also refer Table 9.2):

i) Proximity of Densely Populated Locality - The adoption by company C4, the only company in the sample to have adopted ESP much before the Pollution Control Acts were constituted, was mainly due to the continuous pressure from the nearby community. For company C5 the establishment of a thermal power plant in the proximity of the plant in the later years created an indirect pressure for dust control.

ii) Company's Image in the Market - An important feature about company C4 is that it is one of the 17 cement plants in a group that is controlled by a central corporate office. This group has maximum

share in the cement market and thus the immense importance of maintaining a good market image led to early adoption.

TABLE 9.2

Company	Finance * Availability	Aid to * Co.'s Image	Date of Ordering	Adoption Time Lag (in months)
C1	1	1	Jun. 1982	15
C2	4	3	Feb. 1986	59
C3	1	1	Mar. 1983	24
C4	4	1	Mar. 1978	0
C5	1	2	Jan. 1983	22

* 1: Strongly Yes, 5: Strongly No.

iii) Finance Availability - This is another important factor leading to faster adoption, as in C1, C3 and C5. Its shortage in C4 is obviously compensated by the nature of pressure due to proximity of a city and by the effect on company image.

9.7.6 Fertilizer Industry

The main purpose of adoption of pollution control equipment by the five companies in this sample is to reduce the loss of ammonia and atmospheric pollution. Whereas companies F4 and F5 adopted atmospheric scrubber to minimize the ammonia content of the vent gases, the companies F1, F2 and F3 adopted hydrolyser stripper for process condensate from Ammonia Plant and Urea Plant effluents to reduce the ammonia content. The objective of such adoption was two folds:

1. to recover the costly ammonia for recycling in the plant and
2. to meet the stipulation of Pollution Control Board.

a) R & D and Finance

Presence of an in-house R & D department and availability of finance (refer Table 9.3) play major role in equipment adoption. In company F1 the limited financial resource was due to low annual profit of about Rs. 10 crores (lowest in the sample). But the adoption was due to the presence of the R & D unit which is quite active and has a quite successful history. Similarly in company F3 the R & D unit which frequently enters into technical collaborations with reputed foreign companies pushed the adoption decision.

b) Late Adopters

For the late adopters (companies F2 and F4) the results of earlier adoption were evident, increasing the case of understanding of the process and thus it was quite easy for the companies to adjust to the process. Thus for late adopters low complexity of the equipment along with high communicability and compatibility seem to favour adoption.

c) Public and Cooperative Sector Company

The adoption process of company F5 - a public sector company - was essentially a black box approach. With pollution control regulation becoming more and more stringent the ready availability or finance and the commitment or the top management propelled to the adoption decision. Next the various parameters in the vent gases and their desired level after treatment were advertised in newspaper. Quotations were requested for designing a suitable equipment. The one which has the lowest cost was selected. The company's personnel were neither available for developmental work nor were they interested.

In company F4 - a firm in the cooperative sector - the factors affecting adoption were quite different from that of company F5 although

TABLE 9.3

Company	TECHNO-ECONOMIC FACTORS *		EQUIPMENT ATTRIBUTE *			DATE OF	ADOPTION TIME LAG (in months)
	Information Sources	Resources Men	Comple-xity	Communi-cability	Compati-bility	Order-ing	
F1	1	2	4	3	3	1983	108
F2	2	1	1	1	1	Nov. 1987	164
F3	3	3	4	2	5	Oct. 1987	163
F4	2	1	1	1	1	Dec. 1984	128
F5	4	3	2	2	2	Mar. 1985	132

* 1: Strongly yes, 2: Strongly no.

the adoption was almost at the same time. Ready availability of technical manpower in the R & D department, finance and top managements support favored the decision. The ease with which the process could be grasped along with the communicability and compatibility were the other favorable aspects. The adoption has led to improvement of the company's social image.

9.8 Summary

The primary stimulus for the adoption of pollution control equipment is the recovery value of the valuable which would be otherwise lost. Another major pressure for adoption are the Government rules and regulations. For the success of adoption the involvement of top management is quite crucial. The blocking factors associated with such adoption are high installation cost and lack of reliable equipment. The financial resource availability, location of the factory near a densely populated locality and the improvement in company's image which would follow such adoption also have an impact on the adoption decision.

To a lesser extent the presence of a R & D Department and the type of agreement with the collaborator also influence the adoption time lag. For late adoptors low complexity of the equipment along with high communicability and compatibility seem to favour the adoption of pollution control equipment.

TABLE 1: Effect of Factors on the Adoption of Pollution Control

Co.	TECHNO-ECONOMIC FACTORS Urgency	Info. Sources	Matu-rity	Resources Men	Resources Finance	Top Mgmt	EQUIPMENT ATTRIBUTE Cpty.	Tbty.	Cmlty.	Cpty.	Co.'s Image	RELEVENT DATES Relevent Act	Cmcl. Pdn.	Order-ing	Commissi-oning	Cost (in Cr.)
P1	3	4	4	2	4	3	3	3	5	4	5	Mar. 1974	1965	Apr. 1981	Oct. 1984	0.8
P2	5	1	2	4	1	1	1	4	1	1	1	Mar. 1974	1979	Mar. 1978	Jul. 1979	1.0
P3	4	2	2	1	3	1	3	3	2	4	1	Mar. 1974	1978	Jan. 1981	Sep. 1981	1.0
C1	3	3	4	2	1	1	3	5	3	5	1	Mar. 1981	-	Jun. 1982	Jul. 1986	2.8
C2	2	3	4	3	4	3	4	4	3	4	3	Mar. 1981	1958	Feb. 1986	Apr. 1988	1.0
C3	1	2	2	2	1	1	1	4	3	4	1	Mar. 1981	1960	Mar. 1983	Jun. 1985	1.5
C4	3	2	4	2	4	1	2	4	3	4	1	Mar. 1981	1974	Mar. 1978	May 1981	1.8
C5	2	3	2	3	1	1	2	4	3	2	2	Mar. 1981	1965	Jan. 1983	Jul. 1983	1.0
F1	3	1	4	2	4	1	3	3	3	3	3	Mar. 1974	1973	1983	1987	0.5
F2	4	2	4	1	2	4	1	4	1	1	3	Mar. 1974	1981	Nov. 1987	Dec. 1988	1.5
F3	3	2	4	3	3	1	4	2	2	5	1	Mar. 1974	1970	Oct. 1987	Jul. 1988	0.24
F4	3	2	2	1	1	1	1	4	1	1	1	Mar. 1974	1975	Dec. 1984	May 1986	0.1
F5	2	4	2	3	1	1	2	4	2	2	2	Mar. 1974	1972	Mar. 1984	Dec. 1986	0.2

* Cpty. = Complexity , Tbty. = Trialability Cmlty. = Complexity Cpty. = Compatibility Cmcl. = Commercial
Pdn. = Production

APPENDIX

TABLE 2: Organizational Factors Affecting Adoption of Pollution Control Equipment

Company	Organizational Factors		
	Social Values	Adoption Propensity	Attitude towards Industry *
P1	Service Peace	Low	LF
P2	Ambitious Cooperation	High	MF
P3	Ambitious Determination	Medium	HF
C1	Ambitious Sincerity	High	HF
C2	Sincerity Harmony	Medium	LF
C3	Harmony Peace	Low	LF
C4	Sympathy Fame	Medium	MF
C5	Service Sincerity	Low	MF
F1	Sincerity Service Harmony	Medium	HF
F2	Tolerance Sincerity	Low	LF
F3	Sincerity Ambitious	Medium	MF
F4	Harmony Perseverance	Medium	MF
F5	Power Harmony	Low	LF

* LF: Less Favourable MF: Moderately Favourable HF: Highly Favourable

CHAPTER X

CONCLUSION AND DISCUSSION

10.1 General conclusions

The decision making process in the adoption of pollution control equipment in commercial firms and the factors affecting it has been probed. From the detailed analysis of the adoption process, described in Chapters VIII and IX, important conclusions that emerge are discussed below.

The pollution control equipment adoption decision is essentially a strategic decision, The fulfillment of such priorities depends in the final analysis on the firms solvency - priorities vary as a function of the profit level of the firms. The delay in the responsiveness of a firm can be traced to the organizational characteristics. The key difference in the response pattern of different firms is in the manner in which strategic decisions are sequenced, the sequence in which alternative measures are taken to combat the problem of pollution control and the structural features of organization. All the patterns described (Case I, Case II and Case III in Chapter VIII) have their place in the repertoire of management response to pollution control.

The decision making in adoption - a complex social process - is the result of various sub-processes within and outside the organization. The final outcome of the process is not only the result of corporate strategy and/or the company's policy and technological forces, but also other dimensions, like negotiations among individuals, the values of the

community or culture within which the individuals operate and the decision maker's orientation.

The degree of top management's involvement in pollution control, the improvement in company's image in the reference group which would follow such adoption, proximity of densely populated locality, ease of obtaining financial resources for equipment purchase and implementation shortens the adoption time lag. To a lesser extent the presence of a Research and Development department also has an influence. However high installation costs, lack of reliable equipment and lack of maintenance support tend to be the blocking factors. For late compatibility seem to favour the adoption of pollution control equipment.

10.2 Towards a Broader Analytical Framework of Decision Making Process

The industrial survey, and the response of the various industries and the preceding cases suggests the desirability of development of a broader analytical framework of the decision making process. A number of finer issues which were assessed during personal visits after detailed discussion with various company personnel and could not be included in the cases described because of obvious limitations, are explored in this section. In particular, the diversity of our survey indicates that aiming directly at any universal model at the current crude stage of exploring managerial decisions about adoption of pollution control systems may prove less fruitful than searching for the source of such diversity [15,16,17]. In the cases described earlier significant dissimilarities might be found among decision foci representing different constraints or successive stages of commitment and at different levels.

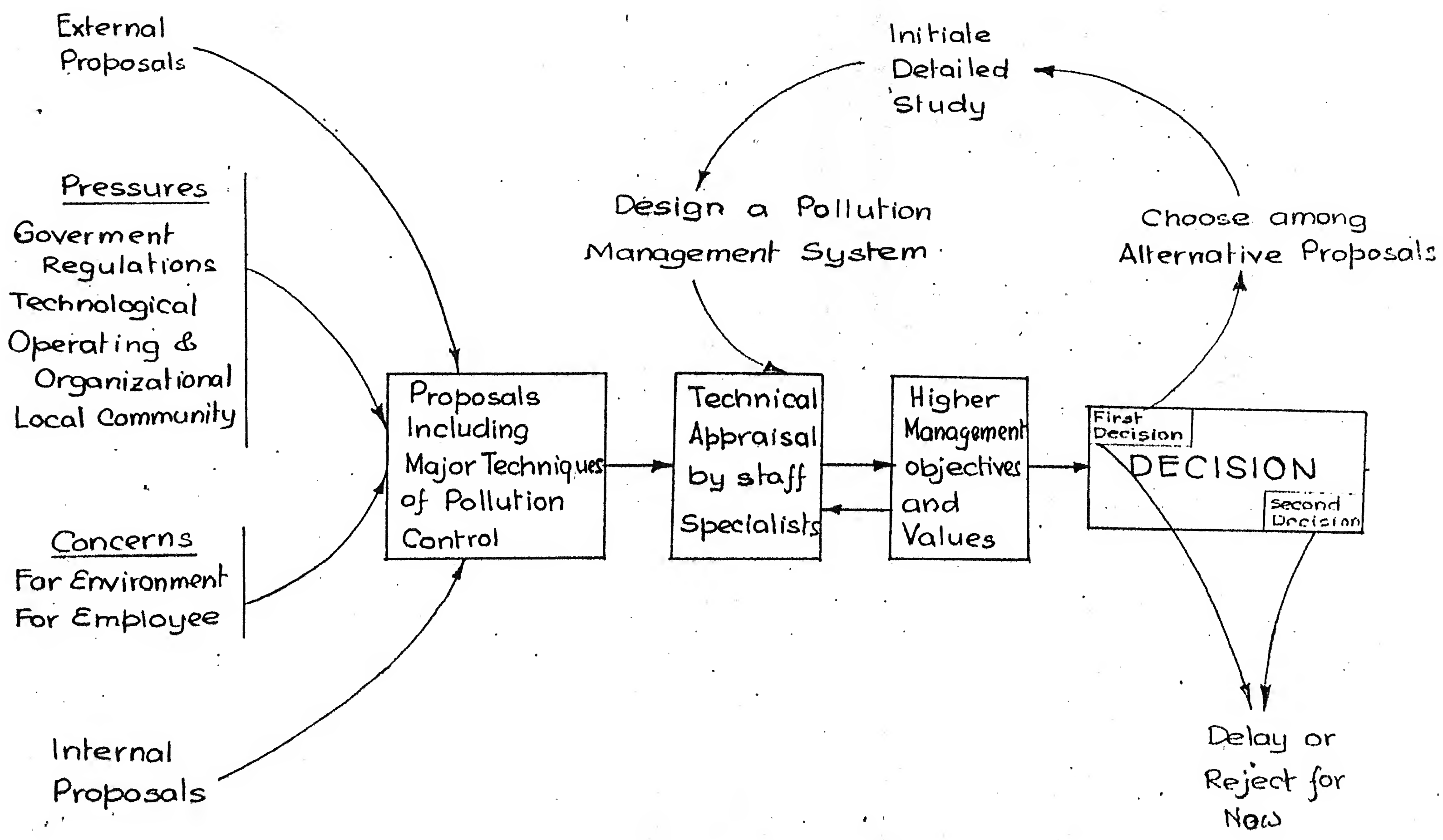


Fig.-10.1: DECISION MAKING PROCESS IN THE ADOPTION OF POLLUTION CONTROL

10.2.1. Decision Making Process

As has been pointed out earlier, adoption is rooted in decisions by the management of individual firms, a brief discussion of the stages leading up to and following such decisions would help to clarify the process. As shown in Figure 10.1, pressures from government and local community, technological developments and internal factors (operating as well as organizational problems) act as one set of inputs to the decision making channels. The other set of inputs are the concern for the environment and the employee. Proposals for coping with such pressures may be generated by external suppliers of facilities/equipments and services as well as by various internal groups. The bearing of such proposals is appraised by staff specialists and assembled into technical recommendations to higher levels of management. Whenever these fall short of yielding inescapable conclusions, not covered by prevailing policies, successive exchanges take place involving responses to higher management's inquiries. Only then is a decision made. A distinct distinction exists between two decision stages (refer Figure 10.1). The first decision is a 'go, not-go' type of decision. It may lead to

i) initiation of internal studies including R & D projects or

ii) rejection or delaying action for the present or

iii) choosing among available proposals.

Choosing one or few (narrowed down from the initial list) alternative(s) leads to initiation of detailed internal studies for designing a pollution management system which is subjected to technical appraisal by staff specialists and forwarded to the higher management for ratification and recommendation. The outcome of this stage is the

second decision: to reject action for the present; or to choose among available proposals, specifying both the level of commitment and the period within which resulting acquisitions or construction should become ready for use. After resources are allocated the engineering design and construction is completed. A considerable period then elapses before results are experienced (including technological findings, recovery yields if any and needed operational adjustments). These delayed sets of results constitute additional inputs to the various channels of pressure as well as to the technical assessments prepared as the basis for the next round of decisions.

10.2.2. Issues Highlighted

The broader framework just now described throws light on a number of important issues. It emphasizes that decisions about adopting pollution control equipment fit into strategic decision processes instead of being essentially unique, that pressures (and concerns) are not continuous and arise only when a proposal is formally moved. Secondly, the focus on decision cycles (and case studies) stresses that many major decisions do not take the form of once-for-all choices among alternatives, but rather represent temporary commitments subject to extensions or modifications on the basis of intervening results and other information, provided the company under consideration is not compelled to follow a time bound programme (dictated by an external agency). Thirdly, the flow chart highlights the role of organizational objectives and managerial values in arriving at major decisions. It is not enough to restate that adoption decisions are based on profitability [18].

10.3 Implications for Organizations

The practical implications of this study may be quite useful to the pollution control equipment adopting organizations so far as evaluating their organizational design is concerned. For the adopting organization, management should recognize that the form of management style promotes the most fruitful use of external information. A top management which is receptive to new ideas and encourages technical experimentation, is a key factor in the ultimate success of adoption of pollution control equipment. Organizational factors such as adoption propensity, attitude towards industry, social values may also affect the decision to adopt pollution control equipment (although conclusive results fail to emerge from this study due to the limited size of the sample studied). Exact characteristics of a supportive organizational climate should be probed and effort should be made to foster them in the organization.

The concept of adoption champions is found to be another factor of importance in most of the successful cases of pollution control equipment adoption. A champion is an individual who is more important in the communication of information than others and who goes beyond his formal organizational role to bridge the organizational and intergroup gaps to promote the product idea. Mr. Paul and Dr. Kapoor in Case I and Case III respectively are examples of such adoption champions. The presence of such an individual to mother and nurture a new pollution control equipment adoption seems to be important in the process of adoption of such equipment. If an optimum rate of adoption of such equipments is desired, management should recognize the importance of the

critical role played by such champions and provide adequate motivation and support them to emerge and to function successfully.

10.4 Implication for Social Policy on Pollution Control

The effect of the deterrent factors associated with pollution control equipment adoption - as emerges from the general conclusion of the study - can be substantially reduced or eliminated if attention is paid towards the formulation of a social policy on pollution control. Attention could be focussed on the following issues which would lead to faster adoption.

1. Bringing together representatives of one industry periodically to deliberate on the issues of effective pollution control. Such meetings would lead to a better generation of ideas, help in dissipation of relevant information and create the atmosphere where pollution control will be considered as a group norm.
2. Provision should be made to exhibit the results of adoption of pollution control equipment(s) which would reduce the risk of adoption by subsequent adopters and at the same time manifest the advantages/benefits of such adoption.
3. Method of joint treatment of effluent from a number of industries should be tried out which could be cost effective.
4. A state level advisory service should be created along with a documentation system. This would aid and advice the company personnel regarding adoption of suitable technology/equipment.
5. More of technology imports, especially pollution control technology relevant to Indian conditions should be encouraged. The existing firms should be allowed to diversify into pollution control

equipment manufacturing and new enterpreneurs in this area should be promoted. All these would lead to increasing the competition which in turn would lead to more reliable equipment and better maintenance support.

10.5 Limitation of Study

The major limitation of this study is the lack of adequate sample size. It is realised that, unless one has a large sample, the assertions cannot be too positive.

Another weakness of this study is that the data upon which it is based are retrospective in nature. This definitely threatens the validity of the findings. Such a weakness could have only been remedied by real time data on the cases. Between the time when the adoption (of pollution control equipment) decisions were actually undertaken and the time when the data were collected, it is quite likely that the organization had undergone some changes due to internal factors, such as changes in management personnel and external factors, such as the national economic situation. Although each respondent was told to answer the questions based on the situation at the time when this decision had actually been undertaken, it is quite possible that the responses reflect the current situation. moreover, some of the respondents had left their organizations and others could have been biased in their responses.

10.6 Direction for Further Work

In order to develop sounder guides for governmental or other efforts to influence pollution control equipment adoption decisions, it seems necessary that future research focus more directly on the process

of relevant decision-making as it is taking place, or immediately after its conclusion - i.e. in 'real time'.

We also did not investigate the communication pattern between the adopter and the supplier/manufacturer of pollution control equipment. It was previously shown that the involvement of the innovator was an important parameter in the success of adoption of new equipments. A future study design should incorporate an in-depth analysis of this variable.

An important question which remains to be answered is as follows: Can we predict behavior regarding adoption of a piece of technology based on a measure of the firms past response to technical ideas?

It is also necessary that future studies give due importance to the recognition of the need to replace the essentially static concept of a given pollution control equipment, implicit in most studies - including the present one - by a more realistic recognition of the likelihood of significant improvements over time which has several important implications.

REFERENCE

1. Allison, G.T., 'Conceptual Model and the Cuban Missile Crisis', American Political Science Review, Sept. 1969, pp. 57-67.

2. Ansoff, H.I., Implanting Strategic Management, USA: Prentice-Hall International Inc., 1984.

3. Beckerman, W., Pricing for Pollution, The Institute of Economic Affairs, 1975.

4. Burns, T., and Stalker, G.M., The Management of Innovation, London: Tavistock Publication, 1961.

5. Carter, C.F., and Williams, B.R., Industry and Technical Progress: Factors Governing the Speed of Application of Science London: Oxford University Press, 1957.

6. Chakrabarti, A.K. and Rubenstein, A.H., 'Interorganizational Technology transfer', IEEE Transactions on Engineering Management, February, 1976.

7. Christopher, K.J., 'Attitude Towards Industry', in Pareek and Rao, pp. 231-233.

8. Christopher, K.J., 'Adoption Propensity Scale', in Pareek and Rao, pp. 293.

9. Downs, G.W. and Mohr, L.B., 'Conceptual Issues in the Study of Innovation', Administrative Science Quarterly, Vol. 21, 1976.

10. Ettlie, J.E. and Rubenstein, A.H., 'Social Learning Theory and the Implementation of Production Innovation', Decision Science, October, 1980.

11. Ettlie, J.E. and Vellenga, D.B., 'The Adoption Time Period for Some Transportation Innovations', Management Science, May, 1979.

12. Fliegel, F.C. and Kivlin, J.E., 'Attributes of Innovations as Factors in Diffusion', American Journal of Sociology, May, 1966.

13. Fliegel, F.C., Kivlin, J.E., and Sekhon, G.S., 'A Cross - National Comparison of Farmers' Perception of Innovation as Related to Adoption Behaviour', Rural Sociology, July, 1968.

14. Gibson, R.E., 'A System Approach to Research Management',

Research Management, May, 1962.

15. Gold, B., Ed., Technological Change: Economics, Management and Environment, Oxford: Pergamon, 1975.

16. Gold, B., 'Technological Diffusion in Industry: Research Needs and Shortcomings', The Journal of Industrial Economics, March, 1981.

17. Gold, B., Rosegger, G., and Peirce, W.S., 'Diffusion of Major Technological Innovation in U.S. Iron and Steel Manufacturing', The Journal of Industrial Economics, July, 1970.

18. Hateez, A., and Begum, S.S., 'Projective Test of Individual and Social Values', in Pareek and Rao, pp. 293.

19. 'High Pollution Potential Industry in India: Cement', Indian Journal of Environmental Protection, January, 1987, pp. 52-54.

20. 'High Pollution Potential Industry in India: Fertilizer', Indian Journal of Environmental Protection, January, 1987, pp. 127-128.

21. 'High Pollution Potential Industry in India: Pulp and Paper', Indian Journal of Environmental Protection, January, 1987, pp. 98.

22. Jain, N.K., Descriptive Law on Polution, Delhi: Akalank Publications, 1985.

23. Katz, E., and Kahn, R.L., The Social Psychology of Organizations, (New York, John Wiley, 1966).

24. Lenihen, J., and Fletcher, W.W., Eds., Energy Resources and the Environment, London: Blackie, _____

25. Lionberger, H.F., Adoption of New Ideas and Practices, Iowa: The Iowa State University Press, 1968.

26. Mallik, V., Handbook of Environmental and Pollution Control Laws, Lucknow: EBC Publishing Pvt. Ltd., 1987.

27. March, J.G., and Simon, H.A., Organizations (New York: John Wiley and Sons, 1958).

28. Mookherjea, A., While Paper on the Environment Sector in the Workshop on Technologies for 2000 A.D., September, 1987.

29. Mumford, E. and Pettigrew, A., Implementing Strategic

Decisions, London: Longman, 1975.

30. Myers, S., 'Industrial Innovations and the Utilization of Research Output', Proceeding of the 20th National Conference of the Administration of Research, 1966.

31. Nystrom, P.C., and Starbuch, W.H., Eds., Prescriptive Models of Organizations, (New York: North-Holland Publishing Company, 1977).

32. Pareek, U., and Rao, T.V., Handbook of Psychological and Social Instruments, Ahmedabad: Samastiti, 1974, pp. 231-233.

33. Radnor, M., Rubenstein, A.H., and Tansik, D.A., 'Implementation in Operations Research and R & D: In Government and Business Organization', Operations Research, June, 1970.

34. Ray, G.F., 'Energy and Innovations' in Ray and Ulhmann.

35. Ray, G.F., and Ulhmann, L., The Innovation Process in the Energy Industry (National Institute of Economic and Social research, Occasional Papers; 30, 1979).

36. Rogers, E.M., and Shoemaker, F.F., Communication of Innovations: A Cross-Cultural Approach, (New York: Free Press, 1971).

37. Rothman, J., Planning and Organizing for Social Change: Action Principles from Social Science Research, (New York: Columbia University Press, 1974).

38. Selltiz, C., Johoda, M., Deutsch, M. and Cook, S.W., Research Methods in Social Relations, USA, Holt, 1963.

39. Shephard, H.A., 'Innovation resisting and Innovation Producing Organization', Journal of Business, April, 1967.

40. Souder, W.E. and Rubenstein, A.H., 'Some Designs for Policy Experiments and Government Incentives for R & D/Innovation Process', IEEE Transactions on Engineering Management, August, 1976.

41. Spencer, D.L., and Woronaik, A., Eds., The Transfer of Technology to Developing Countries, (New York: F.A. Preager, 1967).

42. Stewart, J.M., 'Techniques for technology Transfer Within the Business Firm', IEEE Transactions on Engineering Management, August, 1969.

43. Tornatzky, L.G., and Klein, K.J., 'Innovation Characteristics and Innovation Adoption - Implementation: A

Meta-Analysis of Findings', IEEE Transactions on Engineering Management, February, 1982.

44. Ulhmann, L., 'The Innovation Process: Emperical Results' in Ray and Ulhmann.

45. Utterback, J.M., Allen, T.J., Hollomon, J.H., and Sirbu, M.A., 'The Process of Innovation in Five Industries in Europe and Japan', IEEE Transactions on Engineering Management, February, 1976.

46. Webster, F.W. Jr., 'New Product Adoption in Industrial Markets: A Framework for Analysis', Journal of Marketing (July, 1969.

47. Webster, F.W. Jr., 'On the Applicability of Communication theory to Industrial Markets', Journal of Marketing Research (November, 1968).

APPENDIX

IIT Kanpur

QUESTIONNAIRE ON
ADOPTION OF POLLUTION CONTROL EQUIPMENT
PART - A

1. Could you kindly list the most recent pollution control equipment process adopted by the company?

a) Name of the equipment/process :
b) Cost of acquisition:
c) General description:

d) Characteristics of equipment/process:

e) Purpose of adoption:

2. When did you place the order for the equipment/process?

Month --------- Year ----------

3. When was the equipment/process commissioned?

Month _________ Year __________

4. Was there any particular stimulus or precipitating event that led to an increased need for the implementation of the equipment/process?

5. The following questions have been asked to get some information on your adoption of pollution control equipment/process. If the statement in the left-side box applies very strongly, please circle 1. If the statement in the left-side box applies moderately, please circle 2. If the statement in the right side box applies very strongly, please circle 5 and if it is moderately applicable, circle 4. If the statement in both boxes are equally applicable, circle 3. PLEASE DO NOT CIRCLE MORE THAN ONE NUMBER IN THE SAME QUESTION.

The equipment/process was easy to understand and use.	1 2 3 4 5	The equipment/process was difficult to understand and use.
The equipment/process could not readily be experimented with on a limited basis	1 2 3 4 5	The equipment/process co-uld easily be experimented with on a limited basis
The results of adopting the equipment/process are difficult to observe and communicate to others	1 2 3 4 5	The results of adopting the equipment/process are easily observed and communicated to others
It was very easy for us to adjust to this equipment/process	1 2 3 4 5	It was not at all easy to adjust to this equipment/process.
Before installation of the equipment/process our pollution problem had become very urgent and a solution to it was needed very badly.	1 2 3 4 5	Before installation of the equipment/process our pollution problem was not at all urgent and pressing
The information about the equipment/process obtained from the source did not tell us much .	1 2 3 4 5	The information about the equipment/process obtaine from the source was com-lete, informative and detailed in nature.
Further work/modification was needed to greaat extent before the equipment/process could be used by the company	1 2 3 4 5	The equipment/process was very much suited and with-out any further modification/work could be adopted by the company
There was no problem in getting the people or train-ing personnel necessary to imploement the equipment/process	1 2 3 4 5	There was a need for new personnel or intensive tra-ining of existing personnel before the equipment/proces: could be implemented

There was **no problem** in getting the amount of money necessary for implementation of the equipment/process	1 2 3 4 5	It was a **very difficult** problem to get the money necessary for implementati of the equipment/process
Top management was **not interested** in this equipment/process	1 2 3 4 5	Top management was **very much interested** in this equipment/process
The adoption of pollution control equipment/process **has greatly improved** the company's image	1 2 3 4 5	The adoption of pollution control equipment/process has done **nothing** to the company's image

6. What kind of journals does the company subscribe to?
(Please name three most important ones)

a)
b)
c)

7. What kind of meetings/conferences do company personnel attend?
(Please mention the name of three most important ones)

a)
b)
c)

8. Does the company have an R & D department or centre? YES/NO

If YES, then could you mention
- When was it set-up? Month_____ Year _____
- Is it recognised by the Department of Science and Technology? YES/NO
- When was the recognition received? Month_____ Year _____

9. Has the Government pollution department or board offered any assistance to the company? YES/NO

Could you please mention the nature of assistance offered.

10. What was the labour's or union's reaction to the decision of implementing the pollution control equipment/process?
(Please tick any one of the following)

[ ] Opposition [ ] Acceptance
[ ] Adjustment [ ] Encouragement

GENERAL DATA

11. Name of the Company

12. Nature of the Company : PUBLIC/PRIVATE/JOINT SECTOR
Business "house" of ____________

13. Kindly list the sales and net profit of the Company for the last three years:

Year	Sales	Net Profit
1st yaer		
2nd year		
3rd year		

14. Could you kindly mention in brief about the products and production process of the Company?

Main Products	Main Raw Materials
1.	1.
2.	2.
3.	3.
4.	4.
5.	5.
6.	6.

Production Process in brief:

15. Since when has the Company been in comercial production?
Month _______________ Year ___________

16. Please give the broad organisational structure in brief:

17. List all the pollution control equipments/processes adopted by the Company in the chronological order:

Sl.No.	Month	Year	Equipment/Process	Function	Manufacturer*
1.					a/b/c
2.					a/b/c
3.					a/b/c
4.					a/b/c
5.					a/b/c

*
a) Developed by firm's own technical staff
b) Supplied by an external source
c) Others (Please specify)

Name of the respondent :______________________

Designation :_________________________________

Return to :
Dr. A.P.Sinha/Mr. C.N.Banerjee
IME, IIT Kanpur - 208 016

QUESTIONNAIRE ON ADOPTION OF POLLUTION CONTROL EQUIPMENT

PART B

(In five copies, to be filled by any five senior executives.)

1. In the following item, we would like to know how you feel about some aspects of industry and new equipments. Please encircle the appropriate alphabet on the right side of each statement according to how applicable it is.

    (a) strongly agree
    (b) agree
    (c) neither agree nor disagree
    (d) disagree
    (e) strongly disagree

i.	Industrialisation is mainly responsible for the rise of immorality.	a/b/c/d/e
ii.	Trying out a new idea or practice is a most satisfying experience.	a/b/c/d/e
iii.	Industrialisation lead to slums, congested towns and ill health.	a/b/c/d/e
iv.	Industry makes men industrious.	a/b/c/d/e
v.	These days, there is no end to new techniques, coming up. In these circumstances, the best policy is to wait and see.	a/b/c/d/e
vi.	The nation's progress is mainly due to the industrialisation in the country.	a/b/c/d/e
vii.	If the risk in implementing a new practice is known than the practice would not be tried out.	a/b/c/d/e
viii.	An industrial community is more civilized then a farm community.	a/b/c/d/e
ix.	The concept of the self-sufficient village economy has regained its importance in the context of the present state of our economy.	a/b/c/d/e
x.	In this fast-changing world, one should be able to adjust to changing conditions and ideas.	a/b/c/d/e
xi.	The country can become prosperous without industrialisation.	a/b/c/d/e

2. In this question we wish to know your personal preferences towards different aspects of life. You are given seventeen aspects of life which have to be ranked. All you have to do is to scan over the list and find the aspect you most prefer. Give it a rank of "1". Find something next in your preference and put "2" and so on.

		PREFERENCE
i.	Being broad-minded and tolerant i.e. live and let live attitude.	[ ]
ii.	Having good deal of money and property.	[ ]
iii.	Having a position of authority and power over others.	[ ]
iv.	Living with understanding and adjustment with others.	[ ]
v.	Being affectionate and loving our relatives, friends and others.	[ ]
vi.	Being persistent in our aim by facing all sorts of difficulties in order to reach the goal.	[ ]
vii.	Being earnest and sincere.	[ ]
viii.	Doing exciting or stimulating things by undertaking risk.	[ ]
ix.	Being kind and giving comfort to others.	[ ]
x.	Having a strong desire for something which you want.	[ ]
xi.	Helping others (i.e. people, animals, etc.) without any selfish motive.	[ ]
xii.	Starting some work spontaneously without being persuaded by others.	[ ]
xiii.	Having a strong will.	[ ]
xiv.	Living with peace: desire for mutual existence without quarrels.	[ ]
xv.	Being well known to all.	[ ]
xvi.	Being co-operative: one with others in achieving a common goal.	[ ]
xvii.	Being brave and bold.	[ ]

Name of the respondent :________________________
Designation :________________________________
Company:___________________________________

Return to :
Dr. A.P.Sinha/Mr. C.N.Banerjee
IME, IIT Kanpur - 208 016

QUESTIONNAIRE ON
ADOPTION OF POLLUTION CONTROL EQUIPMENT
PART - C

This part refers to your most recent adoption of pollution control (same as in Part - A of the questionnaire)

1. How did you become aware of the problem/need to have the pollution control equipment/process?

2. How did you become aware of the technological and/or non-technological means of tackling such need?

3. What were the alternatives available otherwise to cope with pollution control?

4. When was the idea for adopting the equipment/process first thought of formally?

   a) Month and Year:

   b) By whom:
   (Designation & Department)

   c) What was the immediate response to this idea?

   Workers:

   Head of R & D:

   Head of other departments:

   Head of maintenance:

   Chief executive:

   Others:

5. Before undertaking the formal evaluation did it go through any informal evaluation? YES/NO

   If yes, please mention:
   - Who was/were involved in the informal evaluation?

   - Please mention briefly the basis of informal evaluation.

6. When the idea was informally evaluated, was it felt that it needs some modifications? YES/NO

If yes, please mention
- What kind of modifications were suggested?

- What modifications were finally incorporated?

- Who suggested the modifications? (Tick any one)

[ ] The generator of the idea
[ ] Any other person

Designation:

7. What was the decision taken at that time?(Please tick and explain where ever necessary)

[ ] Adoption of pollution control equipment/porocess ruled out. If so why?

[ ] Decision about this issue was postponed temporarily. If so, why?

[ ] Asked some person or group to look into the details of this issue.

[ ] Decided to adopt the equipment/process then itself.

[ ] Any other decision (Please specify)

8. Who were involved in deciding upon this issue? (Please tick)

Insiders:

[ ] Chief Executive
[ ] Departmental manager(s)
[ ] R & D staff
[ ] Expert in the field of pollution control
[ ] Others (Please specify)

Outsiders:

[ ] Consultants [ ] Others (Please specify)

9. If this issue was postponed/ruled out (in Q.No. 7), then could you describe how the matter came up again, what factor(s) made it necessary to discuss, whether there was any change in the stands taken earlier and what was the new outcome? (Below we provide space for you to indicate repeated consideration of this issue. Please use BLOCK-'A' and indicate the result of the discussion. If the issue was still undecided you may use BLOCK-'B' as well).

----------------------BLOCK - A ------------------------------

The matter came up again in __________(Month)_______________(Year)
Factors that made it necessary to discuss were

a)

b)

c)

d)

Personnel who were now more favourable for adoption decision than they were earlier were (Please give designation)

(a) (b)
(c) (d)

The outcome was

[ ] Adoption of equipment/process ruled out.
[ ] Decision about this issue was postponed temporarily.
[ ] Asked some person or group to look into this issue.
[ ] Decided to adopt the equipment/process then itself.

----------------------BLOCK - B ------------------------------

The matter came up again in __________(Month)_______________(Year)
Factors that made it necessary to discuss were

a)

b)

c)

d)

Personnel who were now more favourable for adoption decision than they were earlier were (Please give designation)

(a) (b)
(c) (d)

The outcome was

[ ] Adoption of equipment/process ruled out.
[ ] Decision about this issue was postponed temporarily.
[ ] Asked some person or group to look into this issue.
[ ] Decided to adopt the equipment/process then itself.

---

10. How was the final decision for adoption made?

11. Was it decided to have a trial run?

12. We would like to know the main factors that propelled your company to adopt the equipment/process. We would also like to know about the factors that tended to block this decision. In the list below are a set of factors. Please indicate, in the columns alongside, the important propelling factors (on a 1 to 10 scale) and the important blocking factors (on a -1 to -10 scale) in your particular decision.

Scale Rating: 1 = most important propelling factor
10 = least important propelling factor
-1 = most important blocking factor.
-10 = least important blocking factor.

Propelling	Blocking		Factors
[ ]	[ ]	a.	Govt. policy on industrial licensing
[ ]	[ ]	b.	Govt. policy on energy
[ ]	[ ]	c.	Govt. policy on environment
[ ]	[ ]	d.	Tax laws
[ ]	[ ]	e.	Subsidies on installation of equipment
[ ]	[ ]	f.	Public attitude
[ ]	[ ]	g.	Cost
[ ]	[ ]	h.	Capital shortage
[ ]	[ ]	i.	Profitability of investing in pollution control
[ ]	[ ]	j.	Workers' trainining/re-training.
[ ]	[ ]	k.	Safety of community
[ ]	[ ]	l.	Lack of reliable equipment.
[ ]	[ ]	m.	Lack of maintenance support.
[ ]	[ ]	n.	Constraints on supply of an input
[ ]	[ ]	o.	Rise in tarriff
[ ]	[ ]	p.	Location of factory.
[ ]	[ ]	q.	Diversification plan(s)
[ ]	[ ]	r.	Severity of competition
[ ]	[ ]	s.	Expansion plan
[ ]	[ ]	t.	Others (Please specify)
[ ]	[ ]		______________
[ ]	[ ]		______________
[ ]	[ ]		______________

13. At any stage of the adoption process, if there was/were any particular person(s) <u>very much enthusiastic about the decision</u> to adopt the particular equipment/process, then please indicate:

- At what stage was this mostly noticeable?

- Was there any particular reason for this? If so, please mention them below

14. At any stage of the adoption process if there was/were any particular person(s) <u>very much against the decision</u> to adopt the particular equipment/process, then please indicate:

- At what stage was this mostly noticeable?

- Was there any particular reason for this? If so, please mention them below.

15. Was it necessary to take any measures (persuasion, discussion, etc.) to deal with the above resistance? YES/NO

Please indicate the strategy of the measures taken.

16. It is possible that there was absolutely no resistance to the proposal. If so, could you provide some explanatory reason(s) for this.

17. Who were the two most involved people during each of the following stages: (Please give their designations only)

a. Recognition of the need or initiating the proposal	i)	ii)
b. Persuasion of people/managers	i)	ii)
c. Getting information	i)	ii)
d. Technical evaluation	i)	ii)
e. Techno-economic evaluation	i)	ii)
f. Final decision	i)	ii)

18. In the process of decision making, different personnel of your company may have been consulted. Could you please mention below, the personnel involved in such consultation and the purpose of such consultations?

	PURPOSE (see code below)*
a. Head of the department concerned	a/b/c/d/e
b. Head of R&D department	a/b/c/d/e
c. Head of other department(s)	a/b/c/d/e
d. Worker/Union leader(s)	a/b/c/d/e
e. Others (Please specify)	a/b/c/d/e

* CODE
a. Just to keep him informed
b. To seek employee participation
c. To get information on existing methodologies
d. To seek his evaluation of needs so as to aim at future need specification
e. Any other reason (Please specify)

19. How did you arrive at the rough initial specification of the equipment/process?

20. Did the adoption of same/similar equipment/process by other organisation(s) help you in your adoption process? YES/NO

Could you briefly mention how it helped you?

21. Please indicate the importance of the following information sources during the various stages of adoption. (Put 1/2/3/4/5, with "1" indicating most important and "5" indicating least important)

	----- STAGE -----		
	Awareness	Interest	Evaluation
a. Mass media	1/2/3/4/5	1/2/3/4/5	1/2/3/4/5
b. Friends & managers in the company	1/2/3/4/5	1/2/3/4/5	1/2/3/4/5
c. Friends & managers of other companies	1/2/3/4/5	1/2/3/4/5	1/2/3/4/5
d. Consultants	1/2/3/4/5	1/2/3/4/5	1/2/3/4/5
e. Detailed advertisement pamplets from various manufacturers	1/2/3/4/5	1/2/3/4/5	1/2/3/4/5
f. Dealers and salesmen	1/2/3/4/5	1/2/3/4/5	1/2/3/4/5

22. Please mention the type of information (quality, quantity, usefulness, etc.) during the various stages, which in your opinion, would have speeded up the adoption process.

<u>Stages</u>

a. Initial stage

b. Evaluation stage

c. Trial & Adoption stage

23. Did the technological complexity of the equipment/process retard the process of adoption? YES/NO

What was this due to (Please tick)
[ ] lack of technical competence in the Company
[ ] lack of technical competence of equipment supplier
[ ] other reason (Please specify)

24. Was there any study made to look into the financial viability of the whole proposal (of adopting the pollution control equipment (process))? YES/NO

Please indicate the nature of such study?

25. Was any of the following methods used during the process of evaluation (please tick the methods used).

[ ] Cost assessment
[ ] Profitability assessment
[ ] Rate of return assessment
[ ] Others (Please specify)

26. Did you perceive any risk(s) involved with the adoption of the equipment/process? YES/NO

Could you briefly mention how they were reduced.

27. Did any outside participation (i.e. participation of consultants, experts, government officials, etc.) from own country or abroad help in the adoption process? If so, how?

28. Were the personnel of the companies manufacturing or supplying pollution control equipment involved in any stage of the decision making process?

If so, briefly state at what stage(s) and how?

29. By what measures has the state so far improved or handicapped the climate for adoption of pollution control equipment/process?

30. What could be done to improve it further?

QUESTIONS ABOUT PLANNING IN THIS COMPANY

31. The time horizon of <u>formal</u> corporate planning in this company is: (Please tick)

[ ] only annual
[ ] annual as well as a 2/3/4/5 year plan
[ ] annual as well as a very long term plan (of 6 to 10 years)
[ ] no formal planning
[ ] any other (Please specify)

32. Corporate planning in this company is: (Please tick)

[ ] extremely flexible
[ ] not so flexible
[ ] almost rigid
[ ] not applicable

33. This company is seeking new technologies (Please tick)

[ ] rapidly
[ ] in due course
[ ] not at all

34. Long term strategy of the Company : (Please tick)

[ ] Improvement in existing markets (products and productivity)
[ ] Penetrating new markets with existing products
[ ] Diversification into new lines of manufacture
[ ] Integration backward
[ ] Integration forward
[ ] Others (Please specify)

Name of the respondent :____________________
Designation:____________________
Company:____________________

Return to :
Dr. A.P.Sinha/Mr. C.N.Banerjee
IME, IIT Kanpur - 208 016